

Research Problem Review 76-1 ✓

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CREW STATION AND SKILL LEVEL ASSESSMENTS FOR THE MICV/ARSV TURRET

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Robert W. Bauer and Thomas J. Walkush

ARI FIELD UNIT AT FORT KNOX

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Army Project Number

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9 Combat Unit Training *rept.*

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6 CREW STATION AND SKILL LEVEL ASSESSMENTS
FOR THE MICV/ARSV TURRET

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FOREWORD

Field units of the Army Research Institute for the Behavioral and Social Sciences (ARI) perform research involving field experimentation and validation, human factors support and product utilization services, and assessment of military requirements. The ARI Field Unit at Fort Knox, Kentucky, is primarily concerned with performance motivation in training and evaluation of Armor personnel, including crew performance variables in the training school and center environment. The present research investigation is a research analysis of turret crew functions in the Mechanized Infantry Combat Vehicle/Armored Reconnaissance Scout Vehicle (MICV/ARSV) during contact with the enemy, designed to determine the optimum turret crew size and the minimum crew skill levels at which the patrol or squad leader can exercise command and reconnaissance functions. The work was initiated in response to a request by the ARSV Task Force, Fort Knox, in August 1975, under Army Project 2Q763743A773.

The ARI Field Unit, Fort Knox, gratefully acknowledges the support and counsel of staff members of the Armored Reconnaissance Scout Vehicle Task Force including LTC David L. Funk, LTC Marshall D. Schoonmaker, CPT Richard Ardisson, CPT Robert N. Enyart and CPT Donald R. Lightman. Their help was very valuable in the development of the operational sequence diagrams for combat scenarios. The assistance of members of the 5th Cavalry Squadron, 1st Training Brigade, AITA, in establishment of task requirements is also deeply appreciated. These were SSG Gary A. Mincey and SSG Wilbur E. Yocum. SFC Jerry L. Cook of the ARI Field Unit at Fort Knox also provided valuable inputs to operational sequences and skill assessments.


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CREW STATION AND SKILL LEVEL ASSESSMENTS FOR THE MICV/ARSV TURRET

BRIEF

Requirement:

In response to a request by the ARSV Task Force, to conduct a research analysis of turret crew functions in the Mechanized Infantry Combat Vehicle/Armored Reconnaissance Scout Vehicle (MICV/ARSV) during contact with the enemy, to answer two questions:

- (1) How many personnel are needed within the ARSV turret to execute necessary weapons and leadership functions?
- (2) What are the minimal skill levels required of operators within the turret?

The turret was to include the controls and displays for the Bushmaster 25mm cannon, the 7.62 XM238 coaxial machine gun and the TOW multiple shot launcher. The turret was to be manned by a vehicle commander and possibly another operator. The ARSV was to be part of a 40-man scout platoon including a total of five ARSVs and four main battle tanks.

Procedure:

Three combat situations were examined in detail, each one a mission segment from previously developed scenarios. For each mission segment, four or more operational sequence diagrams (OSDs) were developed, including OSDs for the 1-MAN turret and for the 2-MAN turret, in order to show functions and time distributions and potential conflicts between tasks. Detailed analysis of the three mission segments addressed the first question. Review and update of crew duty lists and consultation with personnel familiar with scout operations and weapons addressed the second question on skill level assessment.

Findings:

In response to the first question on the number of turret personnel, results indicated that the combination of weapons systems tasks along with the requirement for reconnaissance functions dictate the need for a 2-MAN turret. Three factors determined this 2-MAN concept:

- (1) Reconnaissance functions are delayed and partly neglected without the 2-MAN turret; the 2-MAN turret permits operation of the primary weapons systems without sacrifice of reconnaissance functions.

(2) The 2-MAN turret provides quicker contact-to-strike times; this advantage is especially significant in TOW engagements.

(3) The 2-MAN turret provides one additional man needed to assist during weapons operations (observing operations, spotting rounds, loading).

As to skill level assessment, Skill Level 3 is appropriate and minimal for Squad Leaders and/or Vehicle Commanders in either the 1-MAN or 2-MAN turret configuration. Skill Level 2 is appropriate and minimal for the gunner/observer in the 2-MAN turret concept. These skill level training requirements must be supplemented to include training for the advanced subsystems and weapon systems contemplated for the MICV/ARSV.

Utilization of Findings:

Results of this analysis have been supplied to the ARSV Task Force and the MICV Project Manager for their consideration in determining the appropriate turret concept for development.

CREW STATION AND SKILL LEVEL ASSESSMENTS FOR THE MICV/ARSV TURRET

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CREW STATION AND SKILL LEVEL ASSESSMENTS FOR THE MICV/ARSV TURRET

INTRODUCTION

This research analysis was initiated in response to a Proposed Statement of Work prepared by the Armored Reconnaissance Scout Vehicle (ARSV) Task Force, Fort Knox, KY, in August 1975. The work plan prepared by Army Research Institute involved an iterative procedure in which critical steps in the analysis would be confirmed by review within the ARSV Task Force. The work plan was limited to comparative analysis of crew tasks, crew function time distribution, and non-turret crew operations only insofar as they impacted upon turret crew operations. The work plan was further limited to the first phase only of the Work Statement, focused on weapons and leadership tasks. Two major questions were to be addressed within the above constraints:

(1) How many personnel are needed within the ARSV turret to execute necessary weapons and leadership functions?

(2) What are the minimal skill levels required of operators within the turret?

The ARSV Task Force and the ARI analysis team agreed upon certain assumptions about the ARSV concept and its turret controlled weapons. The turret must be mounted upon the XM723 MICV/ARSV chassis and has only one hatch above. There are two other hatches in the vehicle top in addition to the rear tail gate/ramp. The turret design in question must include the controls and displays for the Bushmaster 25mm cannon, the 7.62 XM238 coaxial machine gun and the TOW multiple shot launcher.^{1,2} It was further assumed that the turret displays and weapons stations will be manned primarily by a vehicle commander, and, possibly, in addition by another operator.

The scout platoon was selected as the focus of the analysis and, within the platoon, the scout platoon leader's vehicle and the scout squad leader's vehicle. These would represent three of the four leadership positions in the platoon and three of the five ground scout vehicles (GSV) in the platoon. The platoon composition was assumed to correspond to the conceptual armored cavalry platoon consisting of 40 men, and (1) a scout section including the platoon leader's armored reconnaissance

¹ Draft letter of agreement of a MICV/ARSV Bushmaster/TOW integrated turret.

² The Armored Cavalry Platoon: Present and Future. Fort Knox, KY: U.S. Army Armor Center, 1975.

scout vehicle plus two scout squads of two scout vehicles each, and (2) a tank section led by the platoon sergeant and consisting of four main battle tanks.^{3,4}

Three combat situations were selected for study, each one involving an armored scout reconnaissance vehicle in direct contact with an enemy force. In each one it was assumed that the scout vehicle under study would be required to fire either the Bushmaster cannon or the TOW so that the full work load of weapons and leadership requirements could be examined. (In actual combat the platoon leader might be less likely to fire his weapons initially as this would tend to constrain his overall supervision of the platoon.) Given the three combat situations, the sequence of events including elapsed times was compared between the one-man (platoon leader/gunner) and the two-man (platoon leader and gunner) turret configurations. The operational sequence diagrams (OSDs) were analyzed into tasks and subtasks except in the firing sequence where certain steps are indicated and in Figures 8, 9, and 10 where subtasks and steps are shown during portions of the previously developed sequences.

Two OSDs were developed for each of the three scenario segments. Each OSD follows a set of actions resulting from the selection from various decision options. In segment #1 the OSD follows the actions that result from both the "yes" and "no" answer to the question "Can the enemy be seen?" In segments #2 and #3 the answer to that decision block is considered as "yes".

Several additional assumptions were made for the purpose of this study. These include:

1. A well trained crew;
2. Monitoring of weapon feeding be conducted by a crew member other than the vehicle commander or gunner (a "non-turret" crew member);
3. "Non-turret" crew members able to observe the battle environment during the fire mission;
4. Firing of the TOW from the Platoon Headquarters GSV (even though the extended flight time of the weapon may prohibit its usage by the platoon leader under many combat conditions);
5. A stabilized weapon platform;

³ Training Circular 17-36 Test, Conceptual Armored Cavalry Platoon. Fort Knox, KY: U.S. Army Armor Center, December 1974.

⁴ The Armored Cavalry Platoon: Present and Future, 1975, op. cit.

6. That laying of the weapon and accurate visual contact with the target could not be maintained during the rapid GSV motion from its "fired upon" position to its chosen firing position.

7. That in the two-man configuration, both men see and analyze the target in essentially the same time and manner;

8. Times and procedures shown in the OSDs, resulting from the estimates of the ARSV Task Force staff and ARI staff, that are accurate and conservative (minimal) times.

The two major questions are addressed in the next two sections. The first question, on turret personnel, was addressed by detailed analysis of three critical mission segments selected from the Cavalry/Scout Study, 1974.⁵ The second question, on skill level assessment, was addressed by review and update of previous crew duty lists provided by FMC Corporation and consultation with enlisted personnel familiar with scout operations and TOW firing procedures.

ARSV TURRET OPERATIONS

PROCEDURE

In order to respond to the question "How many personnel are needed within the ARSV turret to execute necessary weapons and leadership functions?" analysis proceeded along the following sequence. Three critical mission segments were selected from the two major mission scenarios developed in The Cavalry/Scout Study. These mission segments were limited to the first sixty seconds or less immediately following an enemy contact. Each of these three mission segments was translated into task sequences, and each of these task sequences was developed into two operational sequence diagrams (OSDs), one for the one-man turret occupied by the vehicle commander (platoon leader or squad leader) and another for the two-man turret occupied by the vehicle commander and a gunner/observer. The first six OSDs involved the platoon leader's vehicle in the three engagements. Each of these six OSDs was then reviewed for potential conflicts in task allocations and time-sharing, and critical portions were selected for further analysis because of potential conflict or overloading. These portions were analyzed into task-step sequences in order to reveal the optimal performances which might be expected under the constraints of alternative design concepts (Figures 8, 9, 10). These task-step OSDs showed details which resulted in further revision of the previous task OSDs and yielded data for configuration concept comparisons. The last six OSDs (Figures 11-16)

⁵ The Cavalry/Scout Study. Fort Monroe, VA: U.S. Army Training and Doctrine Command (TRADOC), 1974. (SECRET)

showed the same engagements from the viewpoint of the squad leader vehicle.

RESULTS

The first mission segment involved a BLUE attack in the Middle-East scenario, the segment initiated by an incoming near-miss antitank round against the lead scout team. It was early morning, still dark, as the team moved hastily into partial defilade and closed hatches. The PLT LDR decided to engage with the 25mm cannon system and report to TRP CDR afterward. This OSD was developed in a branched pattern based on an alternative--can or cannot (immediately) see the enemy. Comparison of the OSDs (see Figures 1, 2, 3) for the one-man and two-man configuration revealed a small advantage in contact to strike time but a large advantage in observation times resulting from the added man in the turret (Table 1).

The second mission segment selected was also taken from the BLUE attack in the Middle-East scenario. However, at this point the scout platoon had assisted in taking and consolidating a position on high ground and had assumed defensive positions prior to incoming mortar and direct fire from apparent counterattack elements. The PLT LDR reported prior to opening fire and selected TOW in response. Contact to strike time was reduced significantly in the two-man configuration and, again, observation times increased greatly due to the added man in the turret. (See Figures 4 and 5 and Table 1.)

The third mission segment was taken from the European scenario, a planned withdrawal under attack. In the late afternoon the scout team proceeding as rear guard detected a reinforced tank company about 2500 meters distant. The PLT LDR reported to TRP CDR prior to opening fire and selected TOW to initiate the engagement. Comparison of the one-man and two-man OSDs showed a very significant advantage in contact-to-strike time and large advantage in observation times within the two-man turret concept. (See Figures 6 and 7 and Table 1.)

Analysis of the OSDs was primarily concerned with the time from the initial contact until the initial round reaches the enemy (contact-to-strike time). This end point is almost instantaneous with weapon triggering in the case of the MG or "Bushmaster" firing, but lags considerably after the triggering in the case of the TOW. This choice of end point impacts upon the scenario lapsed times and interacts with leadership and observational times in the comparisons between turret configurations.

Several categories of observation time periods were noted in the analysis of the OSDs. The first category was that of "necessary observation time". This category includes the time lapse required to identify the enemy, acquire and select the target, and to select the battle position. The second category is "concurrent observation time" which is that time which is simultaneous with other tasks, but is not necessary to guide the round to the target. This includes the necessary

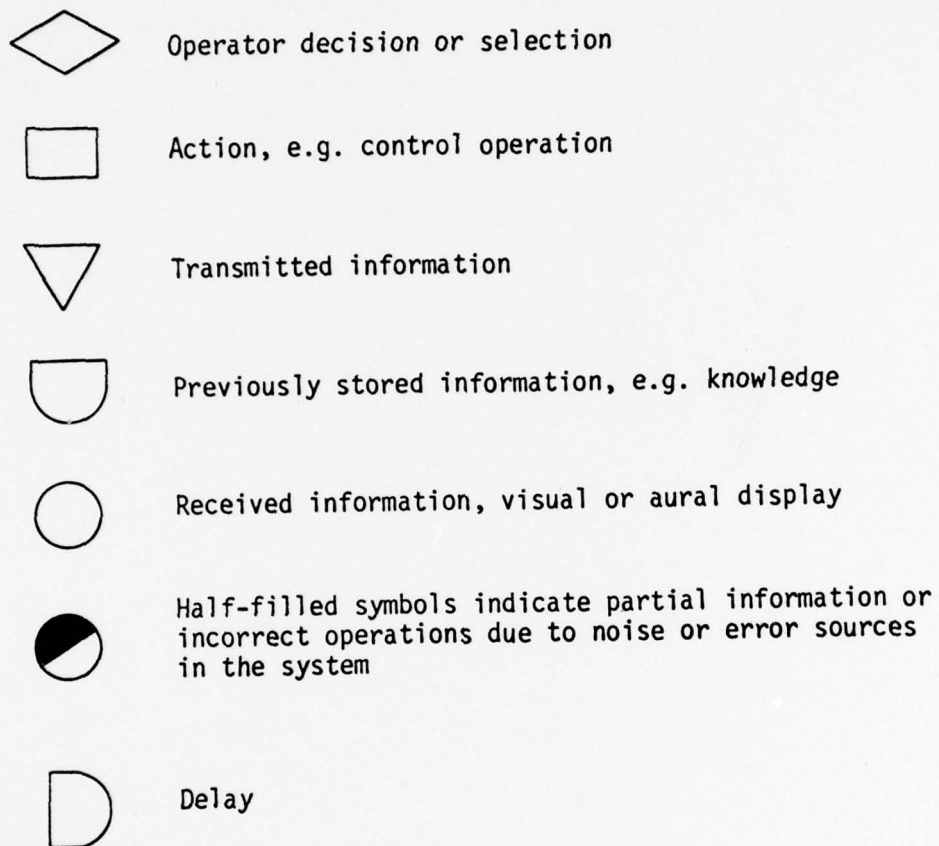
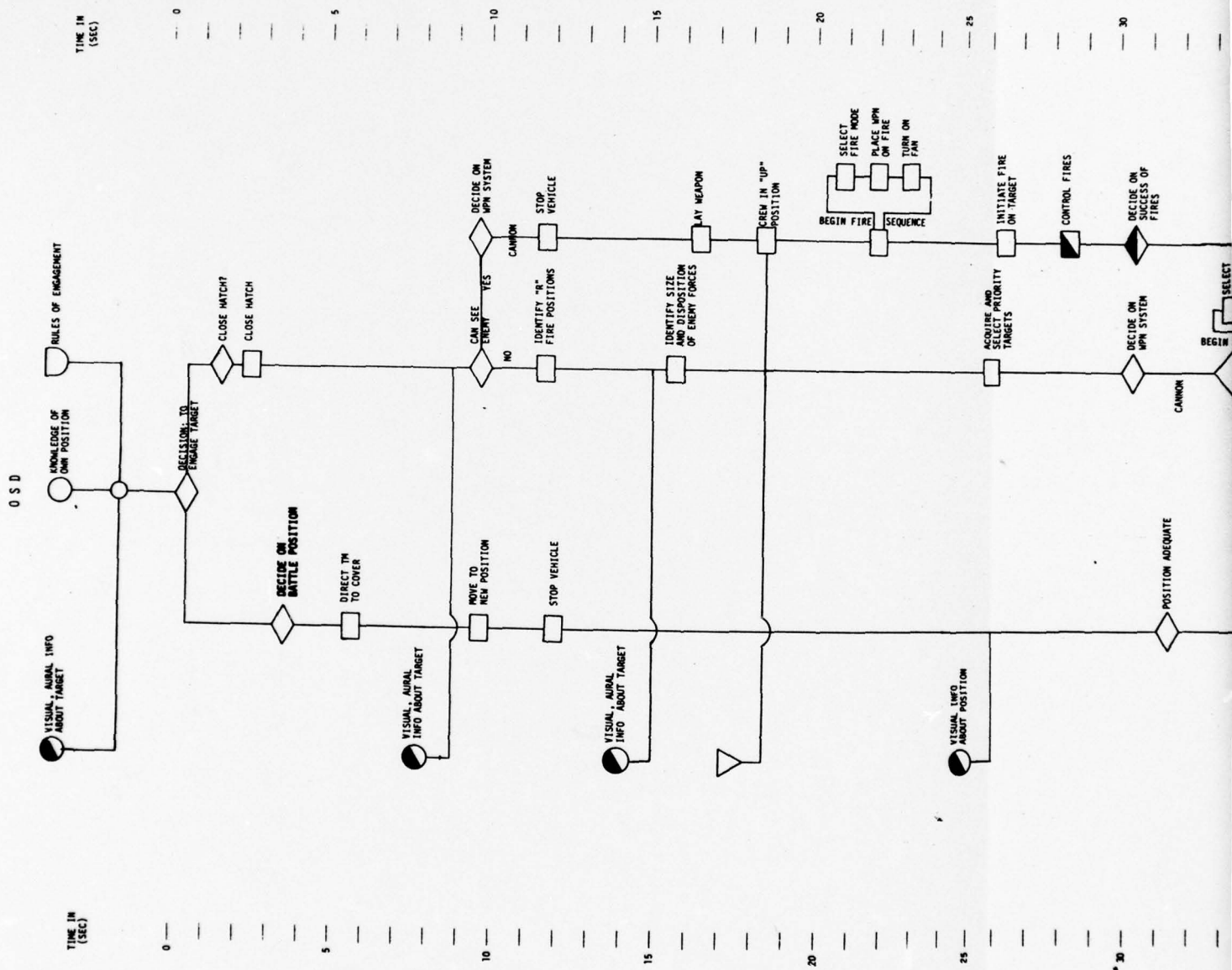


Figure 1. Symbols used in operational sequence diagrams.



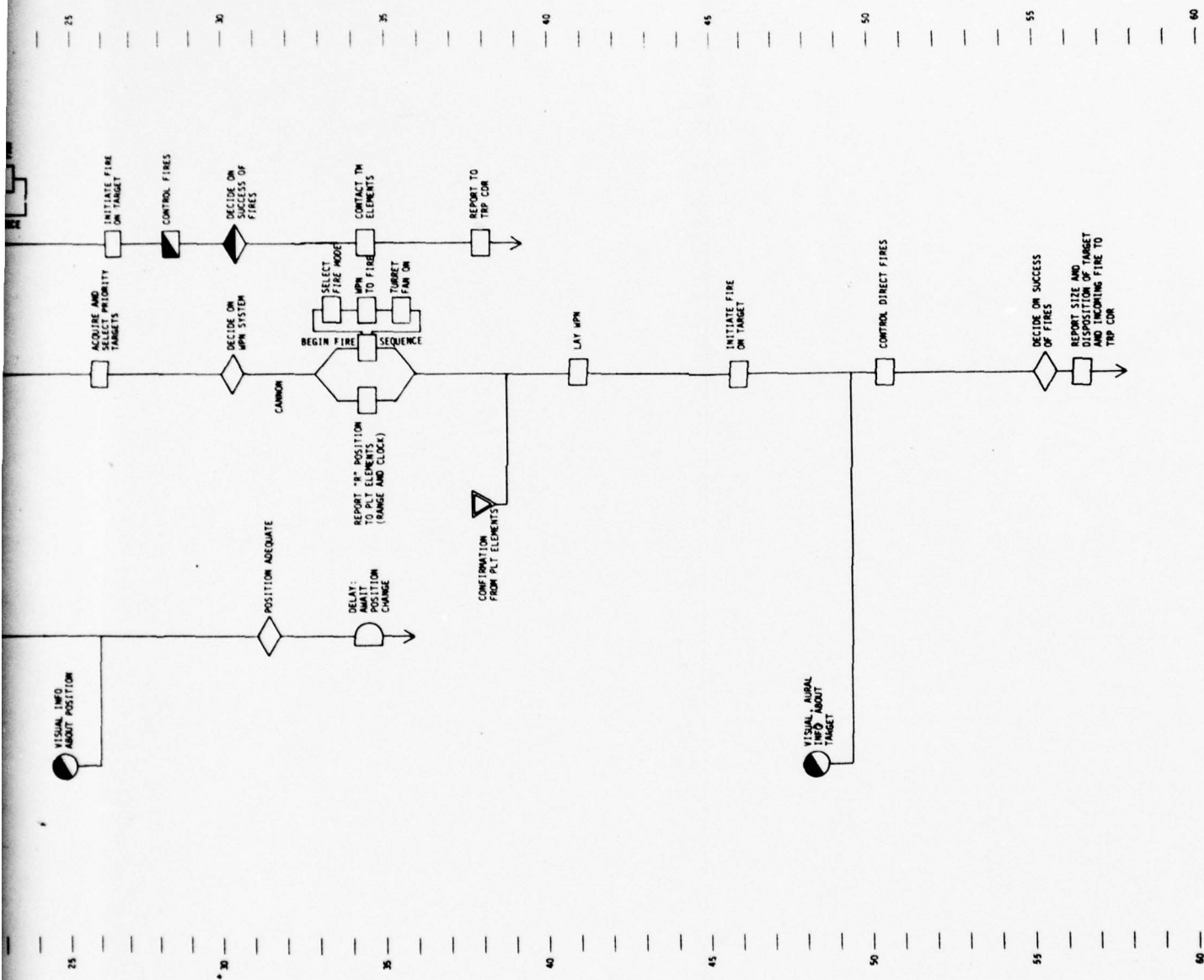
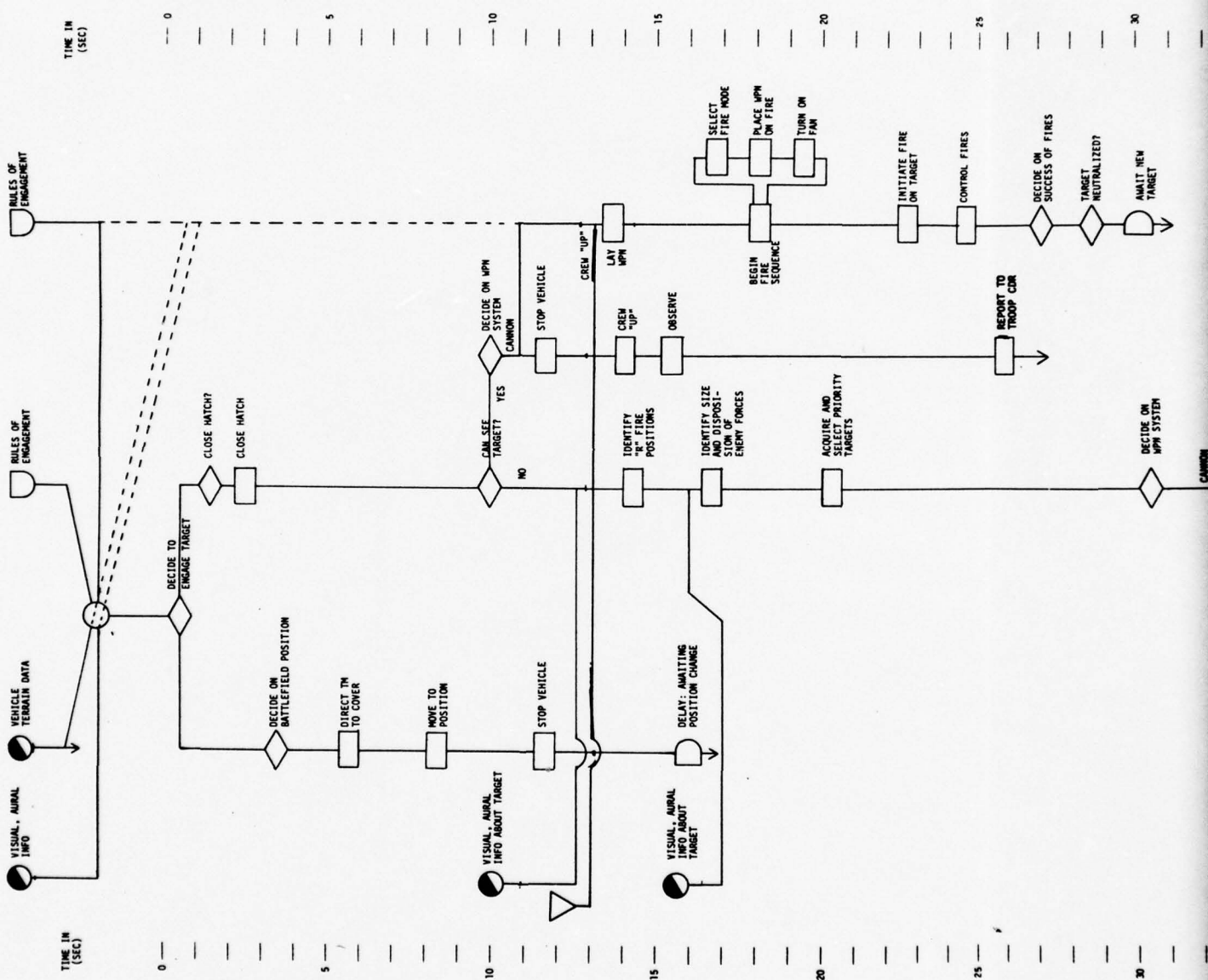


Figure 2. Mission segment one. 1-MAN turret, PLT LDR vehicle, reconnaissance mission, night.

OSD



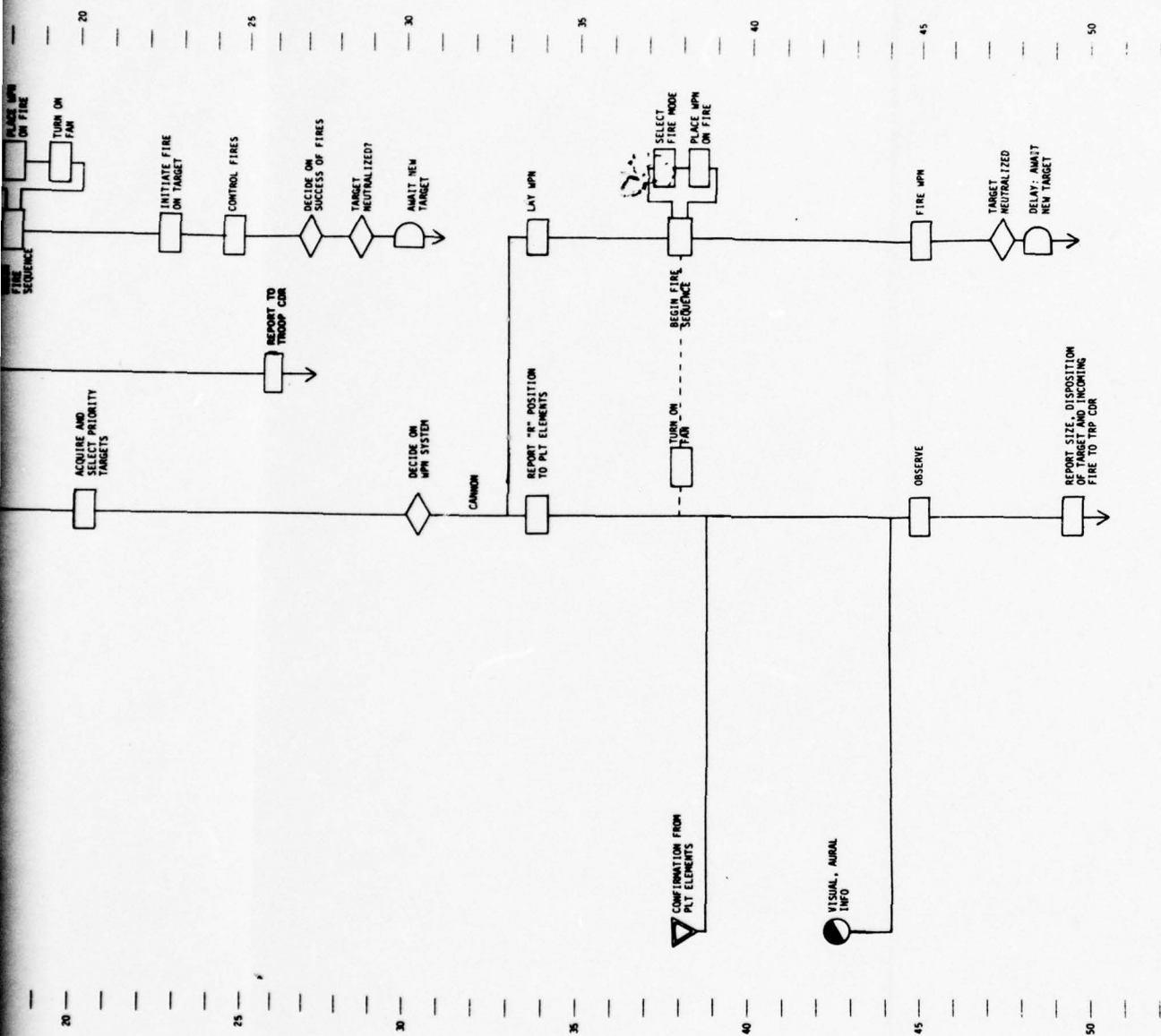
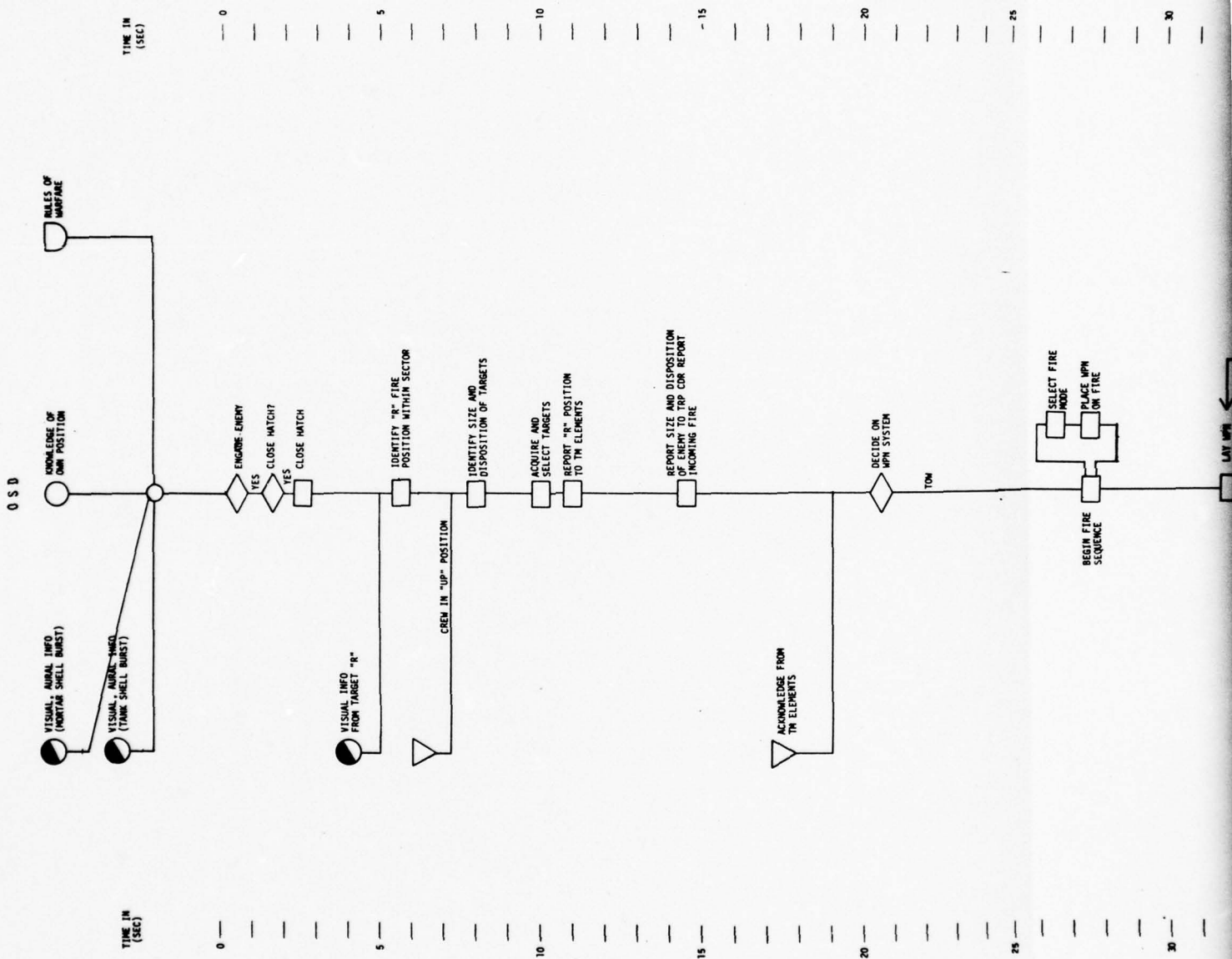


Figure 3. Mission segment one. 2-MAN turret, PLT LDR vehicle, reconnaissance mission, night



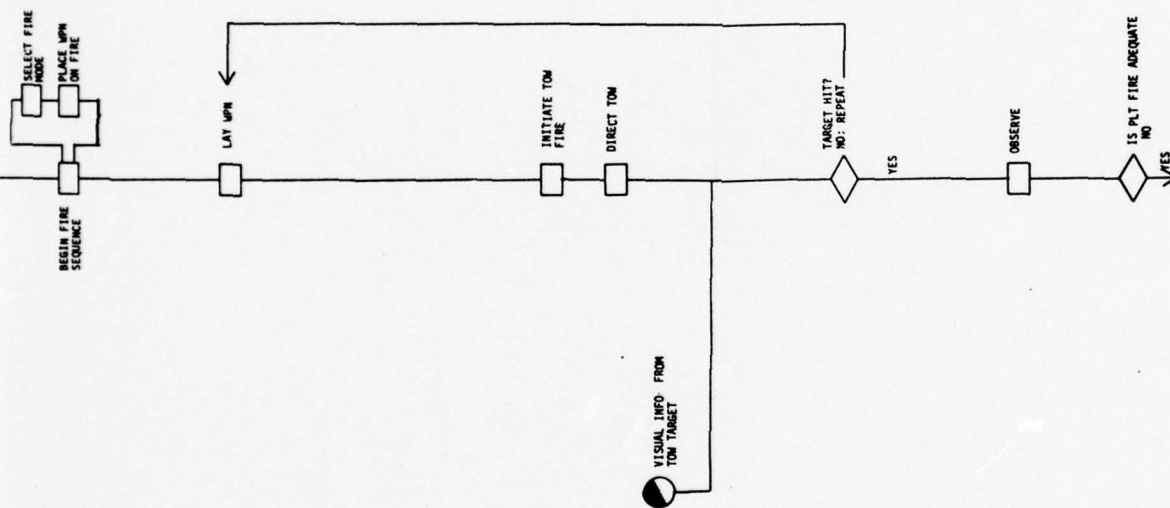
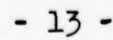


Figure 4. Mission segment two. 1-MAN turret, PLT LDR vehicle, defense, day.

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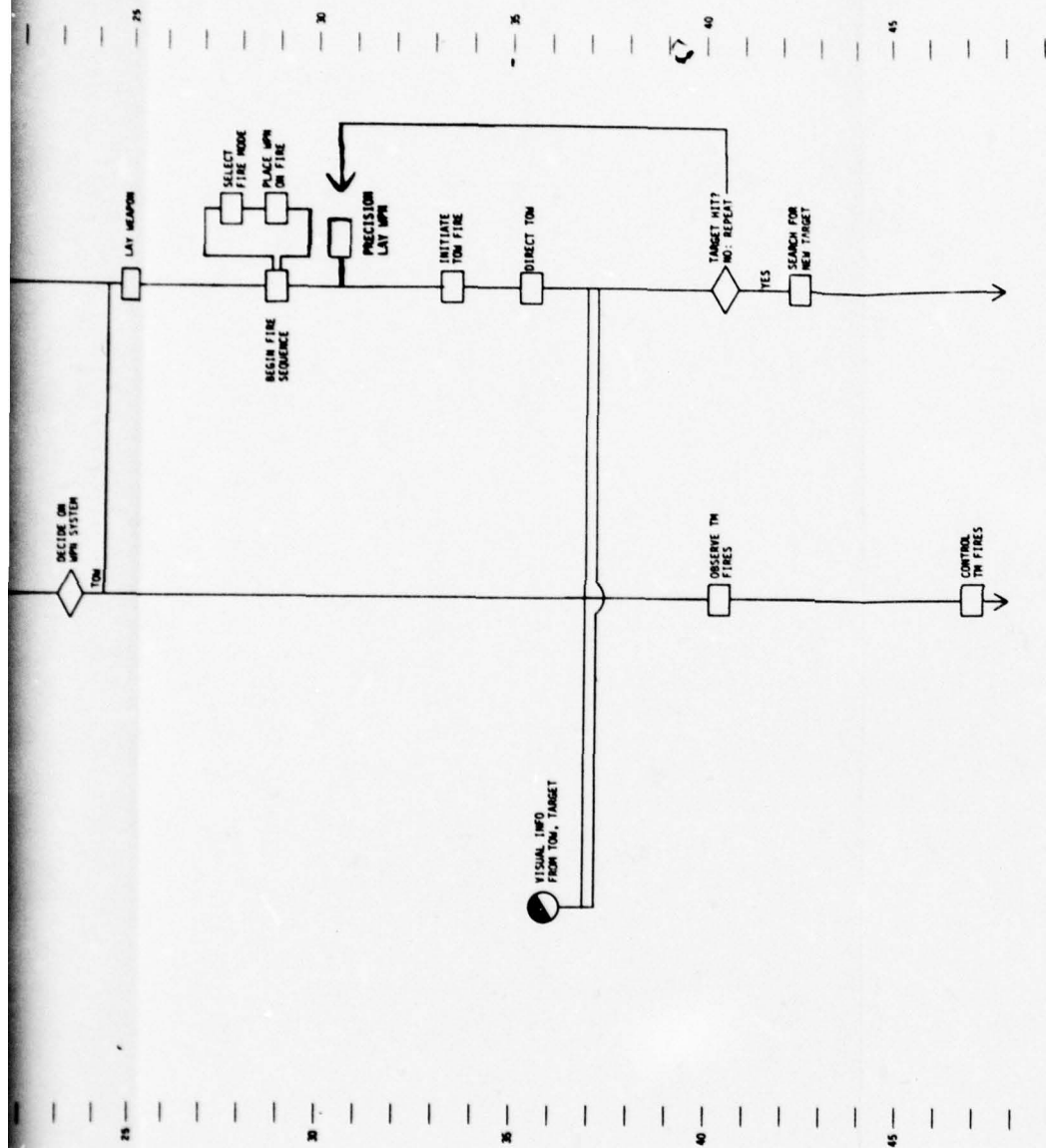
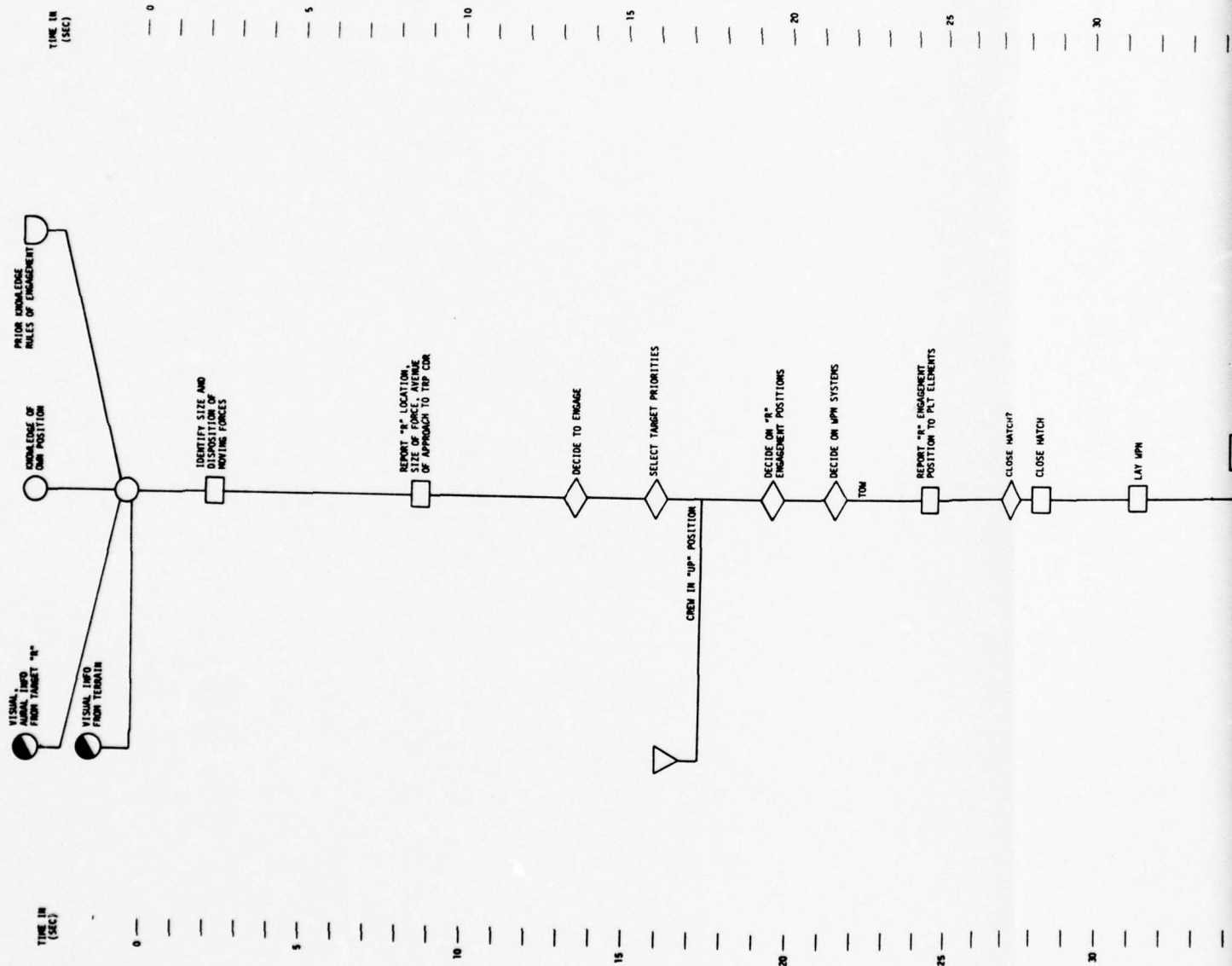


Figure 5. Mission segment two. 2-MAN turret, PLT LDR vehicle, defense. day

OSD



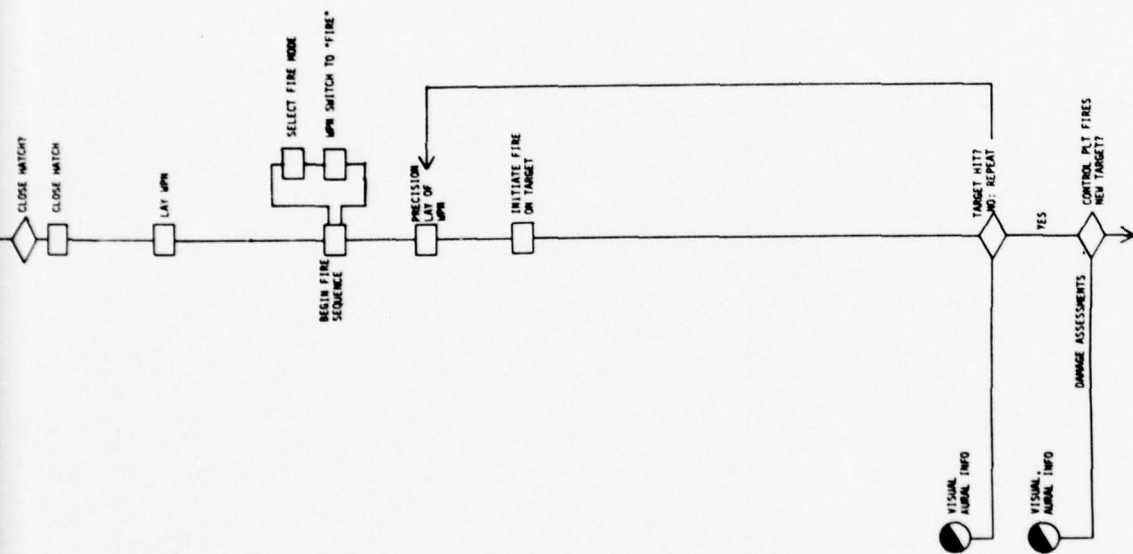
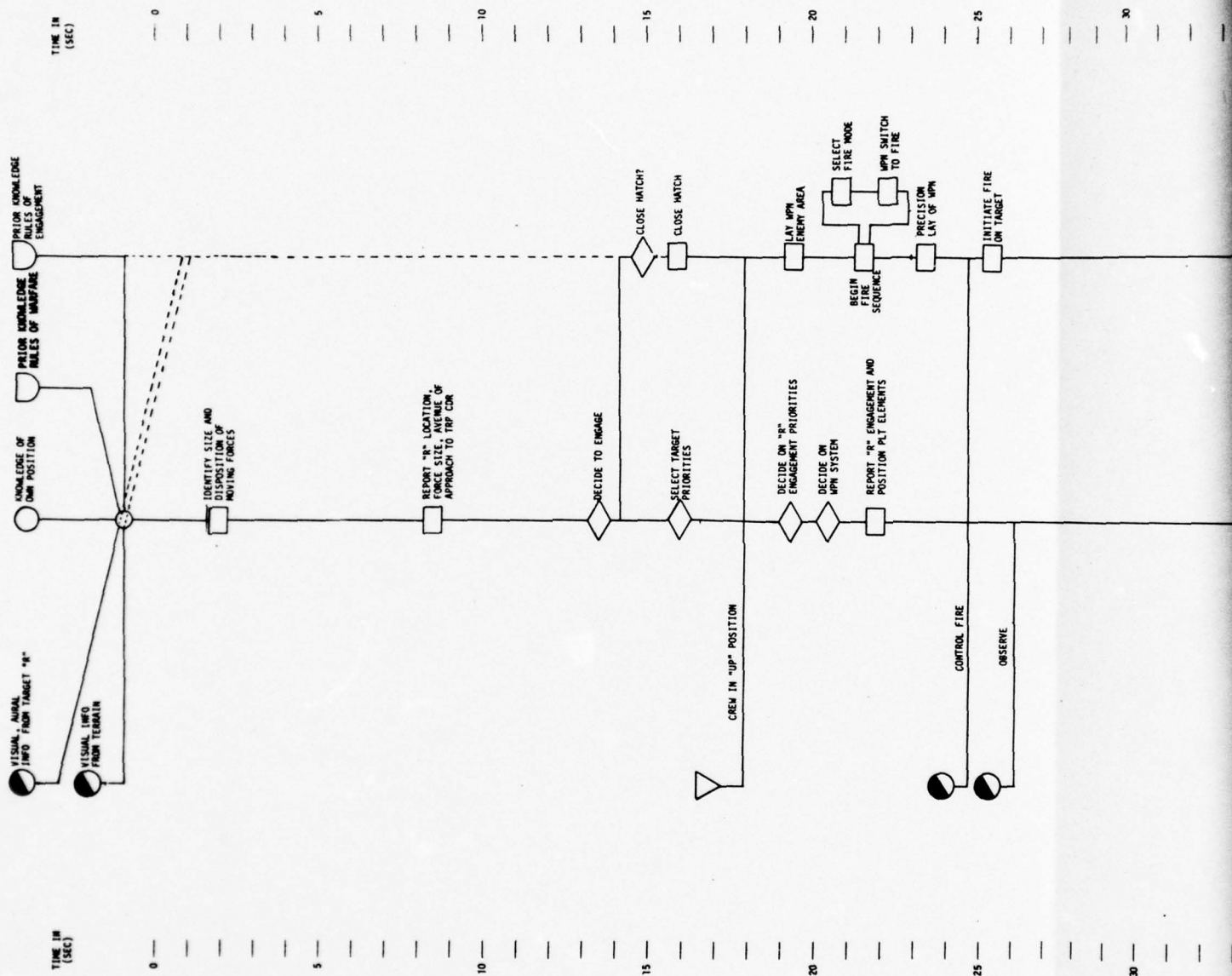


Figure 6. Mission segment three. 1-MAN turret, PLT LDR vehicle, withdrawal, day

OSD



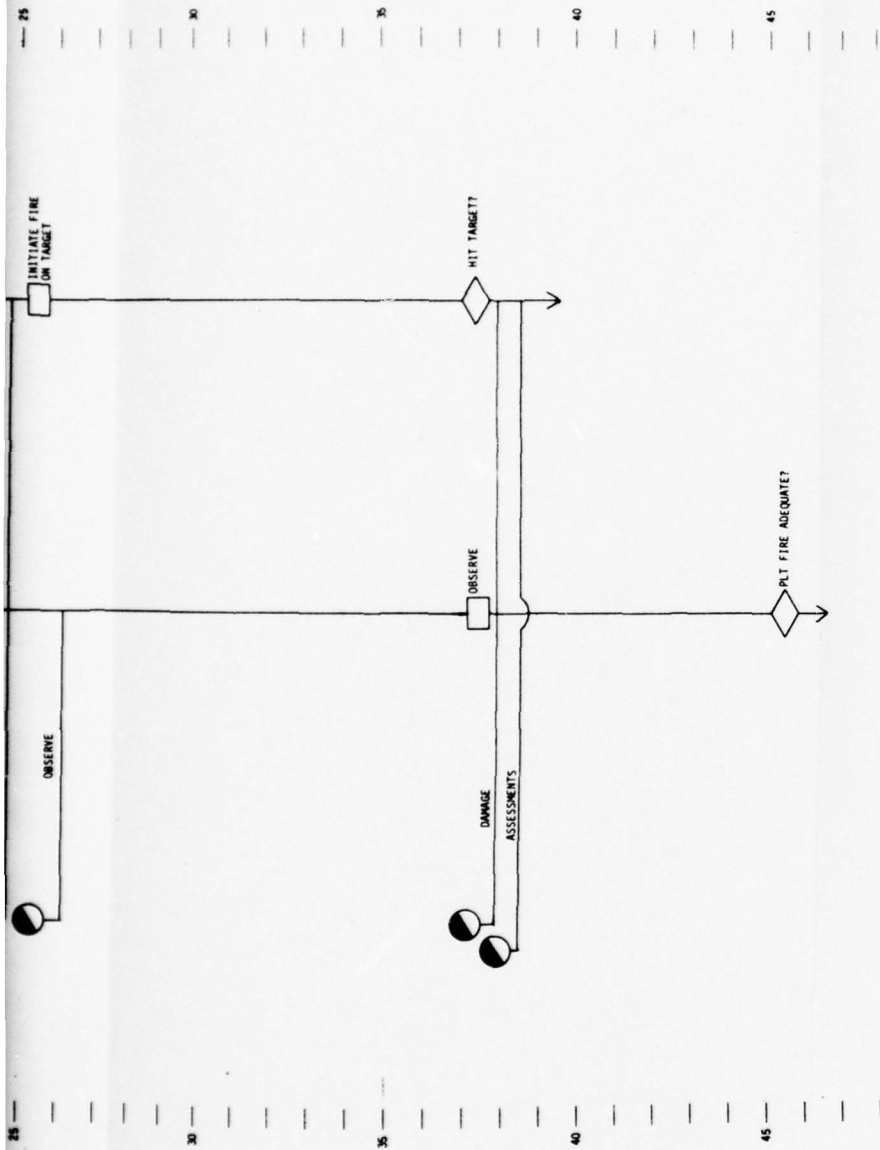


Figure 7. Mission segment three. 2-MAN turret, PLT LDR vehicle, withdrawal, day.

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Table 1

TIME INTERVALS FROM COMPARISON OF OSDs--
PLATOON LEADER (PL) ARSV

		Time, in Seconds				
Mission Segment	Weapon System used	Contact to strike	Necessary observation	Concurrent observation	Other observation	Contact to report
#1 PL only (No)	cannon	46	26	30	0	35
PL + Gnr		46	21	46 + 33	13 + 33	34
#1 PL only (Yes)	cannon	27	16	16	0	38
PL + Gnr		23	14	23 + 11	12 + 11	26
#2 PL only	TOW	48	10	32	0	15 ^a
PL + Gnr		41	10	41 + 25	16 + 25	19 ^a
#3 PL only	TOW	54	22	31	0	25 ^a
PL + Gnr		38	20	38 + 19	19 + 19	22 ^a

^a Reports to TRP CDR before engaging target

observation time and time shared with other tasks such as radio operation which would allow sufficient operator time sharing for at least a limited level of simultaneous terrain observation and information gathering. The final set of observation times is that of "other available time" which would result from delay times while a function performed by another individual is being completed. All of the above times were limited to the interval included in contact-to-strike time.

Given that an important design mission of GSV is reconnaissance, another important time element in this study is that of the "contact to report" time. This is defined as time elapsed from the initial contact with the enemy until the platoon leader first reports the contact to the troop commander. These elapsed time comparisons are shown in Table 1.

In the four cases analyzed, the effect of providing a two-man turret included reduction of contact to strike time by as much as 30% (16 seconds). The effect was most marked in the two cases involving TOW firing (15-30%). The extended missile flight time of the TOW almost prohibits the PLT LDR in the one-man turret from employing his TOW launcher except under very special circumstances.

In all cases studied, concurrent observation time was markedly increased as a result of the addition of the second man to the turret. Some of this concurrent observation time occurred during communications and movement of the vehicle. The value of this added observation can be questioned; however, a large component comes from the gunner's observations prior to the firing sequence and the PLT LDR's observations during firing. These important components are shown separately on other observation times. The advantage in observation offered by the second man in the turret is somewhat mitigated by the capability for observation by non-turret crewmembers. Therefore, 360 degree observation by non-turret crewmembers becomes an essential supplement in the 1-MAN turret.

A major increase in observational time also results in the case of the TOW engagement with the two-operator configuration. This may be especially vital when the range to target exceeds 1000 meters. Ordinarily the long flight time would result in the platoon leader giving the fire mission to another vehicle if the TOW is selected for firing. The platoon leader would then be able to provide cover for the TOW firing vehicle while continuing coordination of the other platoon elements. In the two-man configuration, the gunner in the platoon leader's vehicle could fire the TOW while the platoon leader continued his control duties.

The addition of a gunner to the turret allowed the platoon leader to report earlier to his commander in most situations. In the #1 situation the GSV had to respond to an enemy attack. Segment #1 required a defensive action by the platoon leader and engagement of the enemy as the first priority. In segments #2 and #3 the platoon leader was able to select the time of engagement, which allowed him to report to the troop commander prior to engagement. In the situations where the platoon leader was free to pick the specific engagement time, he could make his report in about the same time regardless of the turret configuration.

Table 2

EXCLUSIVE TIME INTERVALS PRIOR TO FIRST
STRIKE ON TARGET AREA--PL ARSV
(2-MAN OBSERVATION TIMES MAY BE PARTIALLY CONCURRENT)

Mission Segment	Time, in Seconds			
	Communication Time	Observation Time (Excl Comm)	Fire Control Time-to-Strike	Contact-to-Strike Time
#1 (Yes)				
1-MAN	4	12	11	27
2-MAN	7	29	10	23
#2				
1-MAN	13	13	22	48
2-MAN	13	53	16	41
#3				
1-MAN	8	24	22	54
2-MAN	12	45	19	38

In order to check the feasibility of the elapsed time intervals and to get clarification of potential overload or conflict situations, selected portions of the subtask OSDs were analyzed into steps. These step OSDs revealed very high rates of activity for the turret operator in the one-man turret, requiring very rapid communications and extremely quick target acquisitions to meet the time limits estimated (Figures 8 and 9).

Step analysis of the 2-man configuration on mission segment three also showed high rates of activity for both the PLT LDR and gunner upon detection of the enemy force. However, the team operation in target acquisition, firing of the TOW and damage assessment was illustrated in this diagram (Figure 10).

Three major system functions of the scout platoon are communication, observation and fire control. In order to separate these time-consuming activities for further examination the OSDs were reviewed to eliminate time sharing by any one crew member in the estimates entered into Table 2. All time estimates entered were limited to the interval prior to first strike on target area. Two-MAN-concept observation times were additive since concurrent observations did not necessarily involve time-sharing. The advantage of the two-man turret concept in reduced contact-to-strike time and increased observation time is apparent.

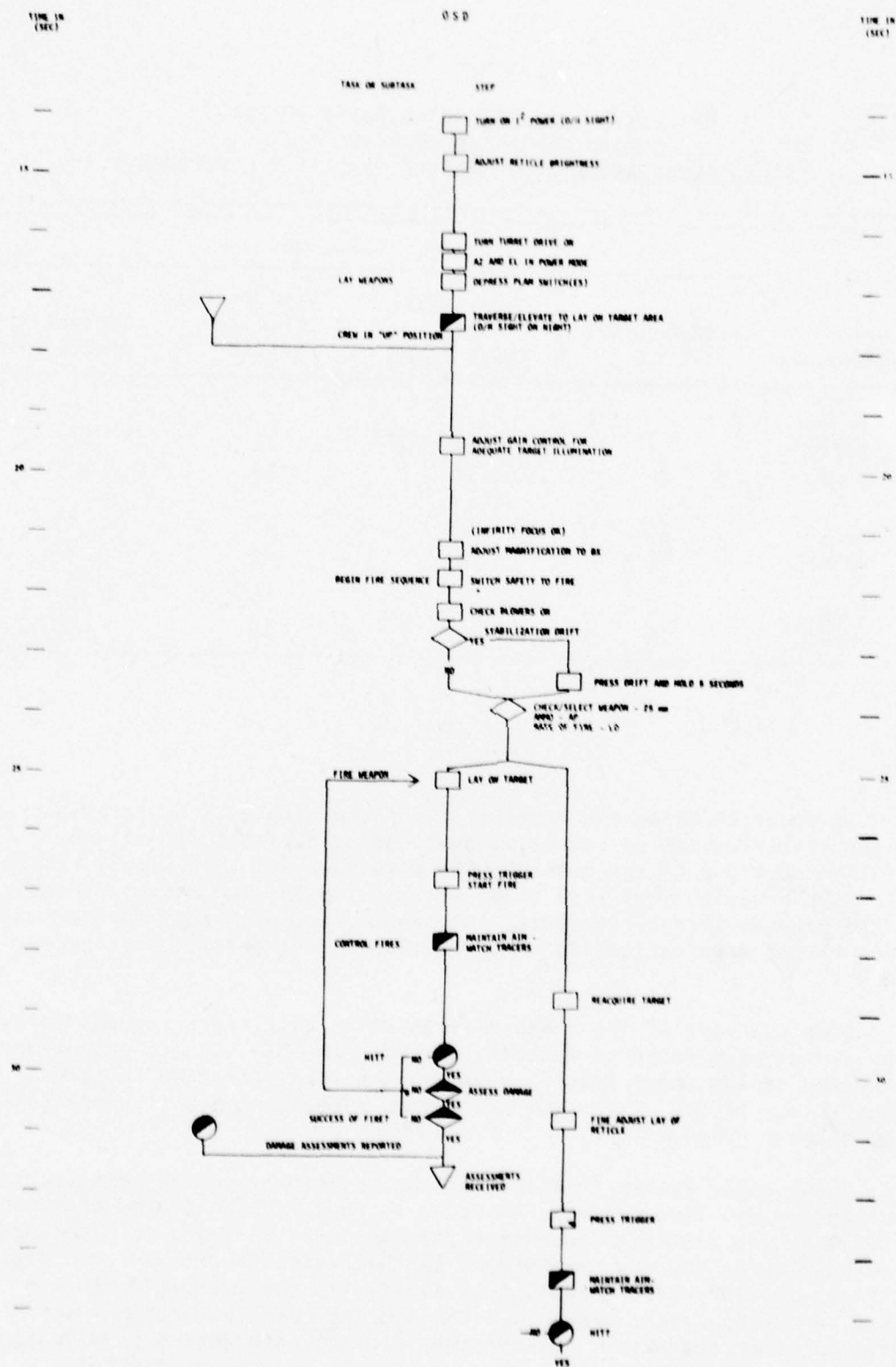
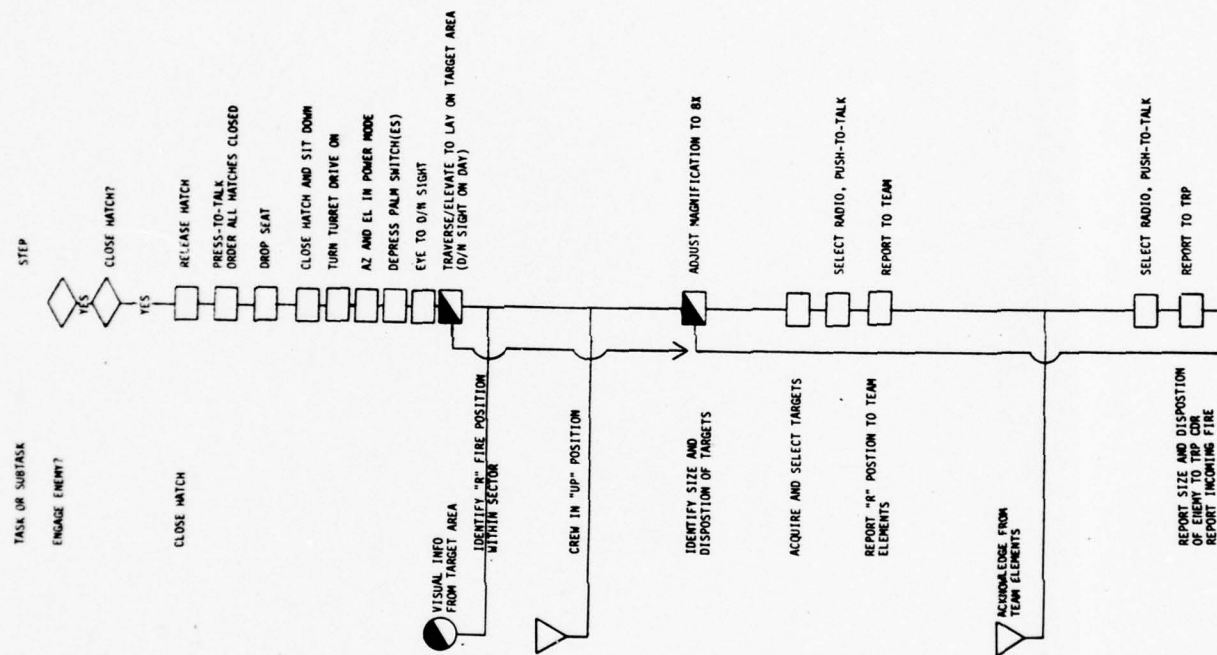


Figure 8. Task-step OSD. Mission segment one, first fire sequence, 14-35 seconds elapsed, 1-MAN turret, 25mm cannon.

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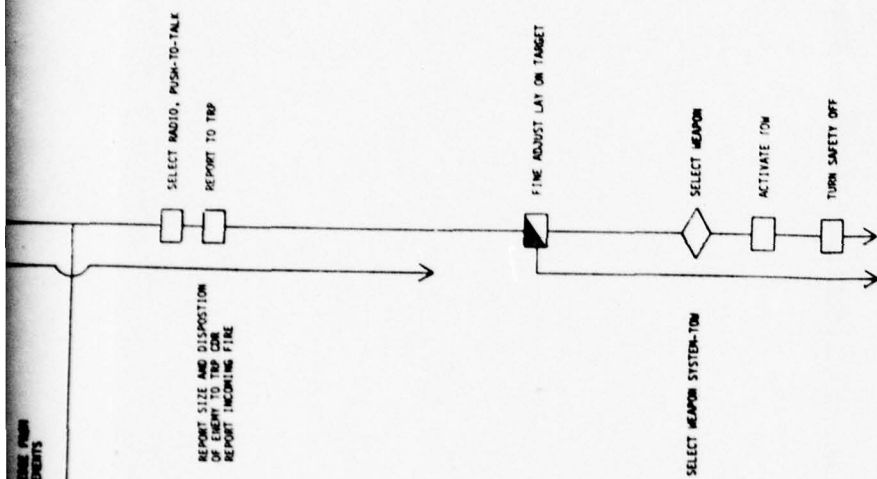
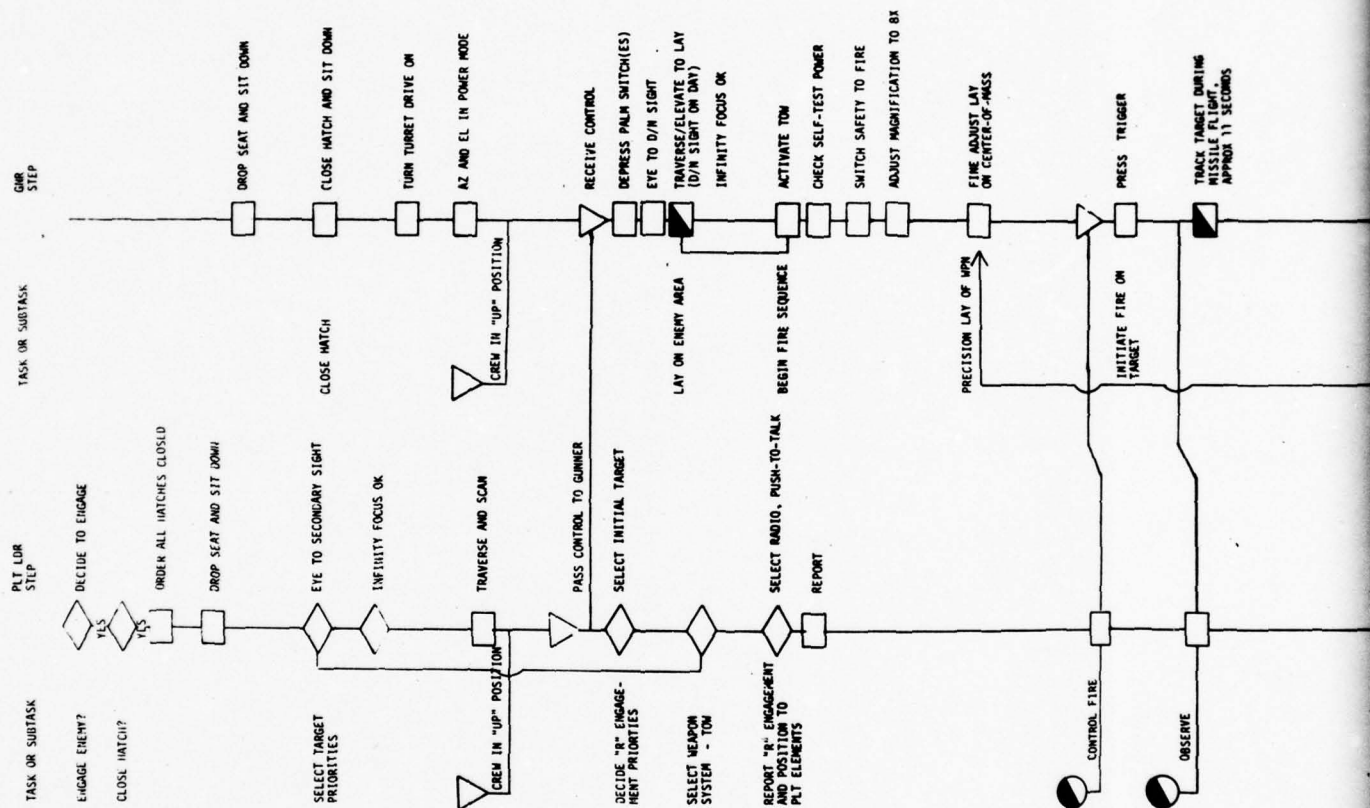


Figure 9. Task-step OSD. Mission segment two, first 23 seconds of engagement, 1-MAN turret, TOW.

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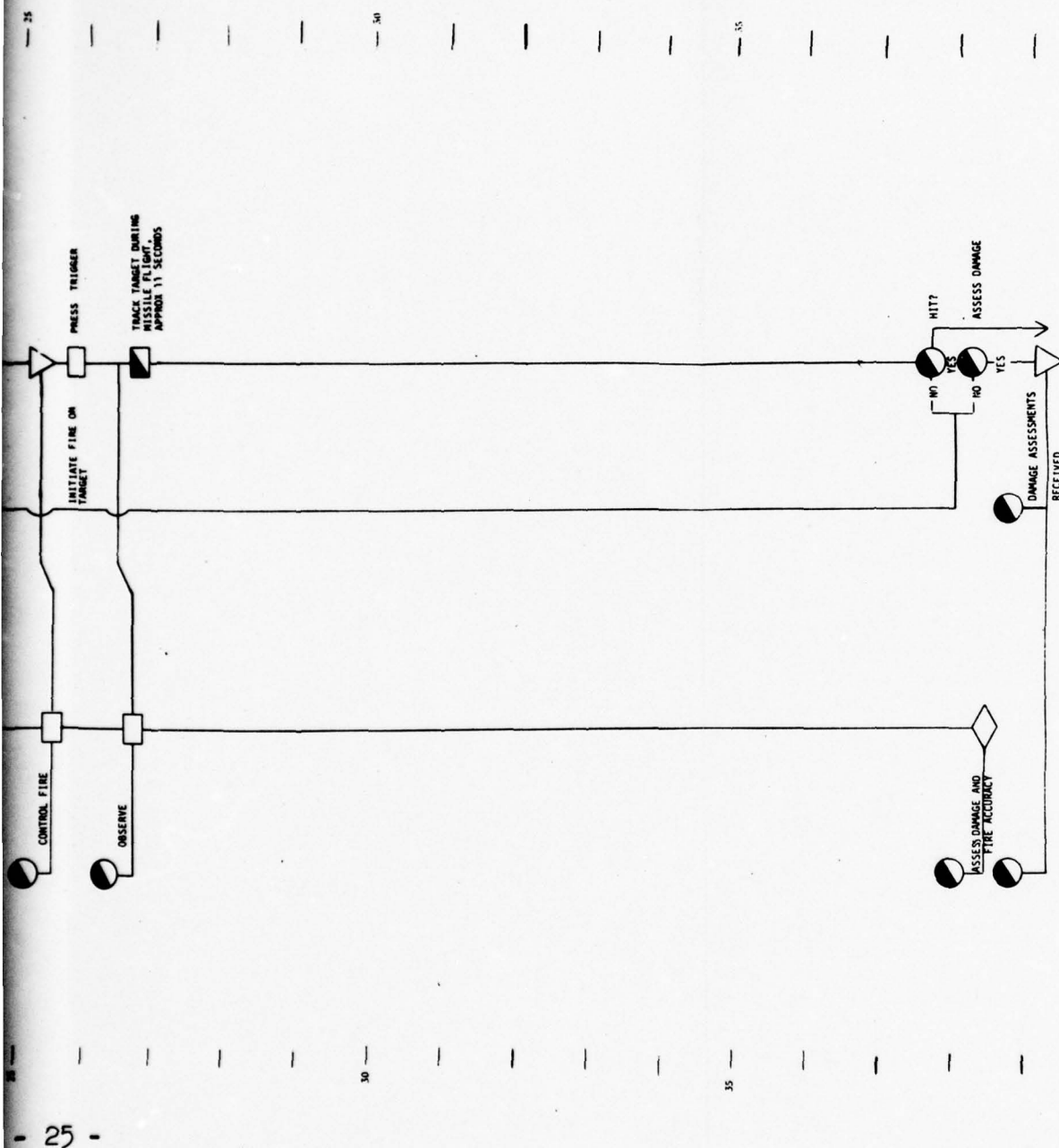


Figure 10. Task-step OSD. Mission segment three, 13-40 seconds elapsed, 2-MAN turret, TOW.

Figures 11 through 16 show the operational sequences within a squad leader's turret during the same mission segments examined previously. In each case the squad leader is given responsibility for firing at the command of the platoon leader. The OSDs are developed down to the task and subtask level (but not step-level).

Contact-to-strike time was somewhat reduced in three of the four instances and observation time was markedly enhanced by the addition of the gunner to the turret of the squad leader vehicle (Table 3).

Table 4 illustrates the relative shift of emphasis within the crew functions from reporting and observation to fire control within the one-man turret as compared with the two-man turret of the squad leader vehicle. Mean time spent in observation and communications combined shifted from 77% in the two-man turret to 60% in the one-man turret. Fire-control occupied the other 40% of the time prior to strike on target area in the one-man turret engagements. More important, perhaps, is the fact that the vehicle commander can spend 100% of his time observing and communicating in the two-man turret.

CONCLUSIONS

Consideration of the high rates of activity revealed in the step analyses and the relatively reduced observation times shown by the 1-MAN turret concept in Tables 1 and 3 suggests that the 1-MAN turret design may not permit the coordination and efficient achievement of scouting tasks required. Even though observation by non-turret crewmembers can compensate (at least in part) for these reduced observation times, analysis of the OSDs showed that the 2-MAN configuration also permitted reductions in both contact-to-strike times and contact-to-report times. The reduction in contact-to-strike times was particularly significant in the application of the 2-MAN turret in TOW engagements. Another very important advantage of the 2-MAN configuration lay in the 200 to 400% increase in observation time prior to first strike on target (Tables 1, 2, 3, 4). Tables 2 and 4 showed the relative shift of major task time toward fire control in target engagements at the expense of observation in the 1-MAN concept. It may be concluded that the vehicle commander in the 1-MAN turret will spend 40 to 50% of his time manning weapons in a combat engagement. In the 2-MAN turret concept the vehicle commander will spend nearly 100% of his time observing and communicating. Observing and communicating are the subtask elements in the major task of conducting reconnaissance.

The combination of the Bushmaster-TOW weapons in the one-man turret configuration easily permits the application of the ARSV system to attack functions while reducing its reconnaissance efficiency. The two-man turret configuration with the same weapons tends to restore capability to conduct reconnaissance while permitting TOW and cannon engagements with reasonable efficiency.

Table 3

TIME INTERVALS FROM COMPARISON OF OSDs--
SQUAD LEADER (SL) ARSV

Mission Segment	Time, in Seconds				
	Weapon system used	Contact to strike	Necessary observation	Concurrent observation	Other observation
#1 SL only (No)	cannon	42	26	26	0
SL + Gnr		42	28	42 + 33	9 + 33
#1 SL only (Yes)	cannon	27	16	16	0
SL + Gnr		23	14	23 + 10	13 + 10
#2 SL only	TOW	43	13	21	0
SL + Gnr		38	13	38 + 21	17 + 21
#3 SL only	TOW	53	31	31	0
SL + Gnr		38	19	38 + 19	19 + 19

Table 4

EXCLUSIVE TIME INTERVALS PRIOR TO FIRST STRIKE ON TARGET AREA--SL ARSV
(2-MAN OBSERVATION TIMES MAY BE PARTIALLY CONCURRENT)

Mission Segment	Time, in Seconds			
	Communication Time	Observation Time (Excl Comm)	Fire Control Time-to-Strike	Contact-to-Strike Time
#1 (Yes)				
1-MAN	3	13	11	27
2-MAN	8	28	10	23
#2				
1-MAN	8	19	16	43
2-MAN	8	52	16	38
#3				
1-MAN	5	26	22	53
2-MAN	5	51	20	38

Q S D

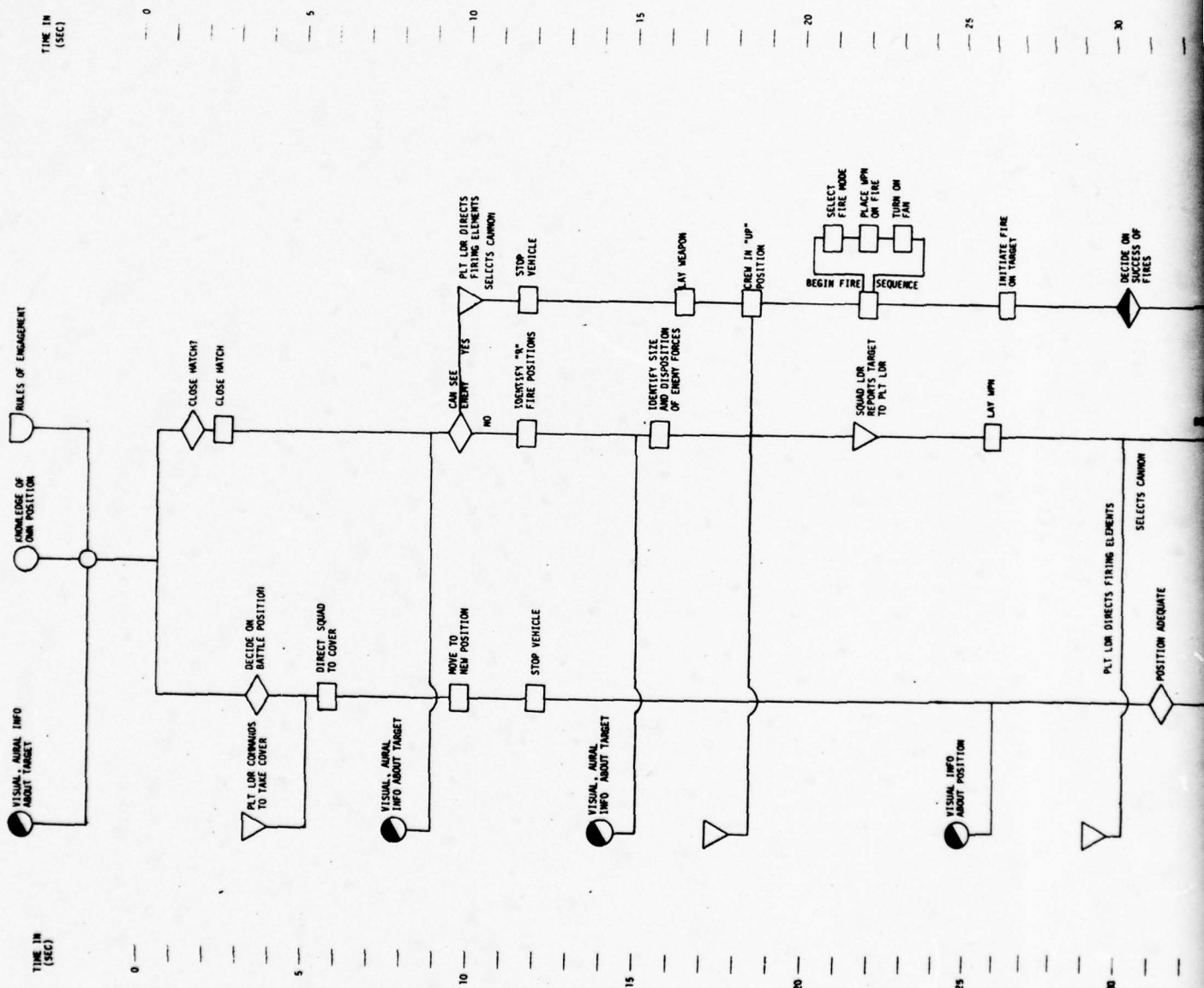
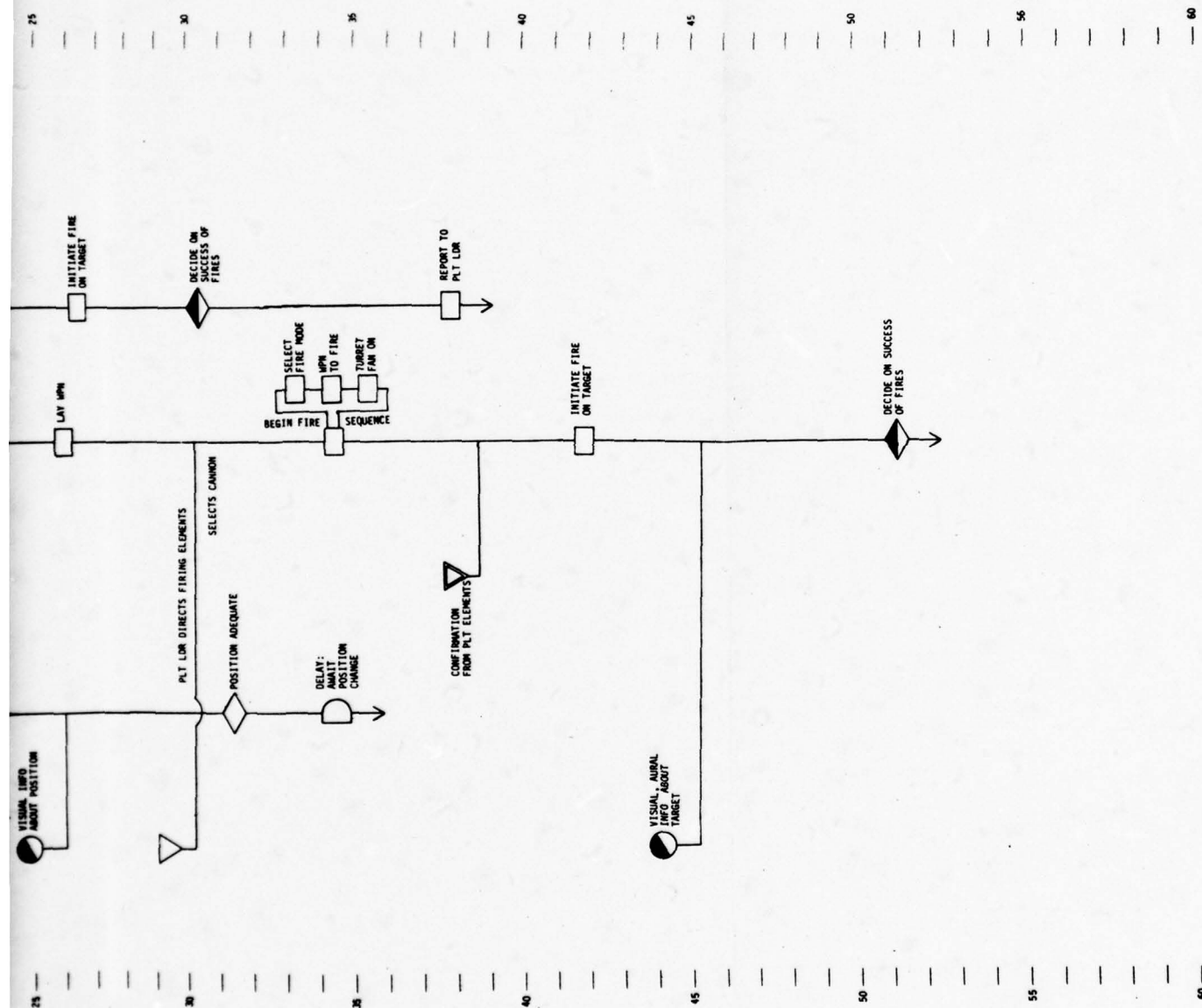
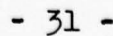


Figure 11. Mission segment one. 1-MAN turret, SQD LDR vehicle, reconnaissance mission, night.





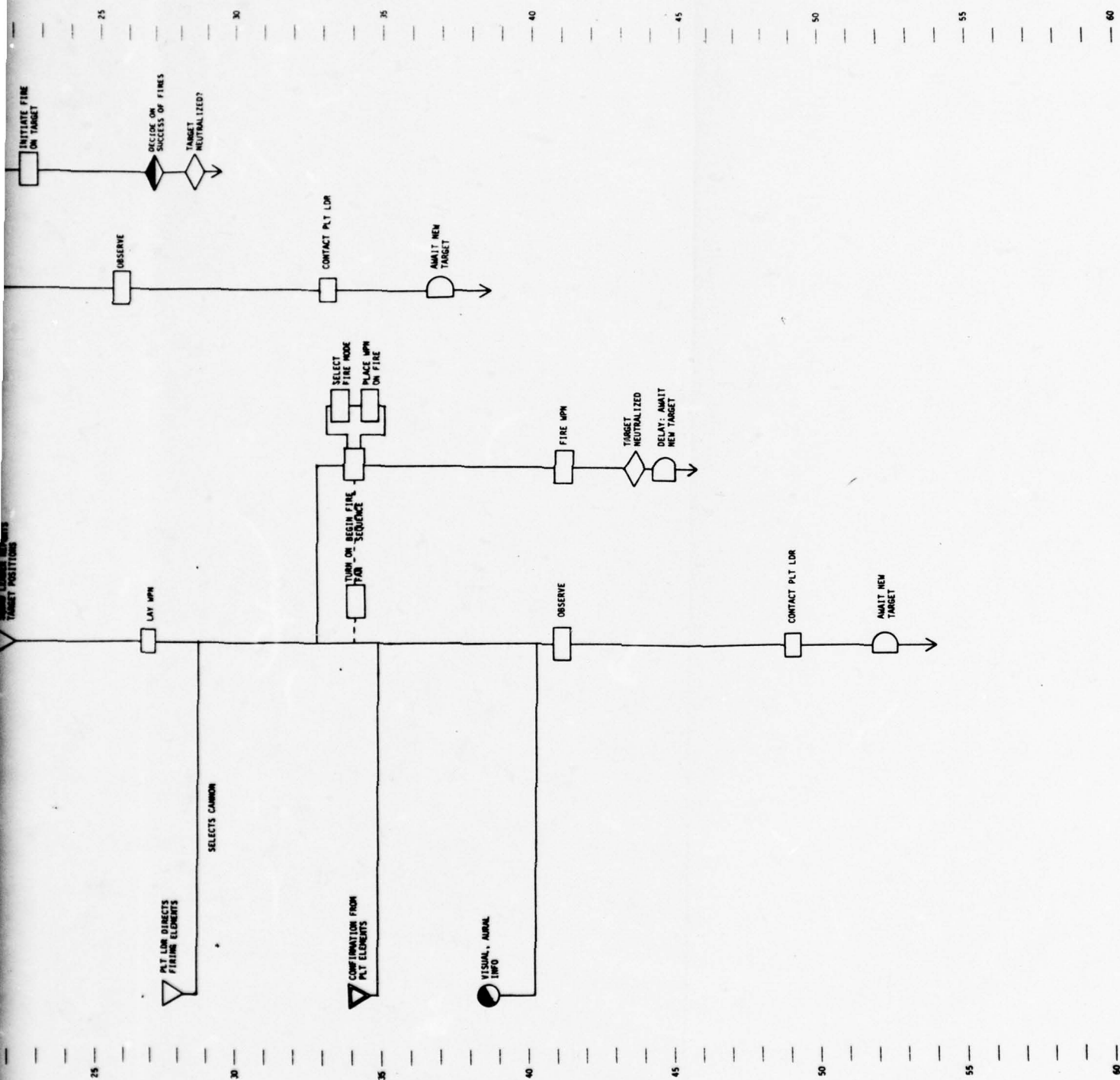
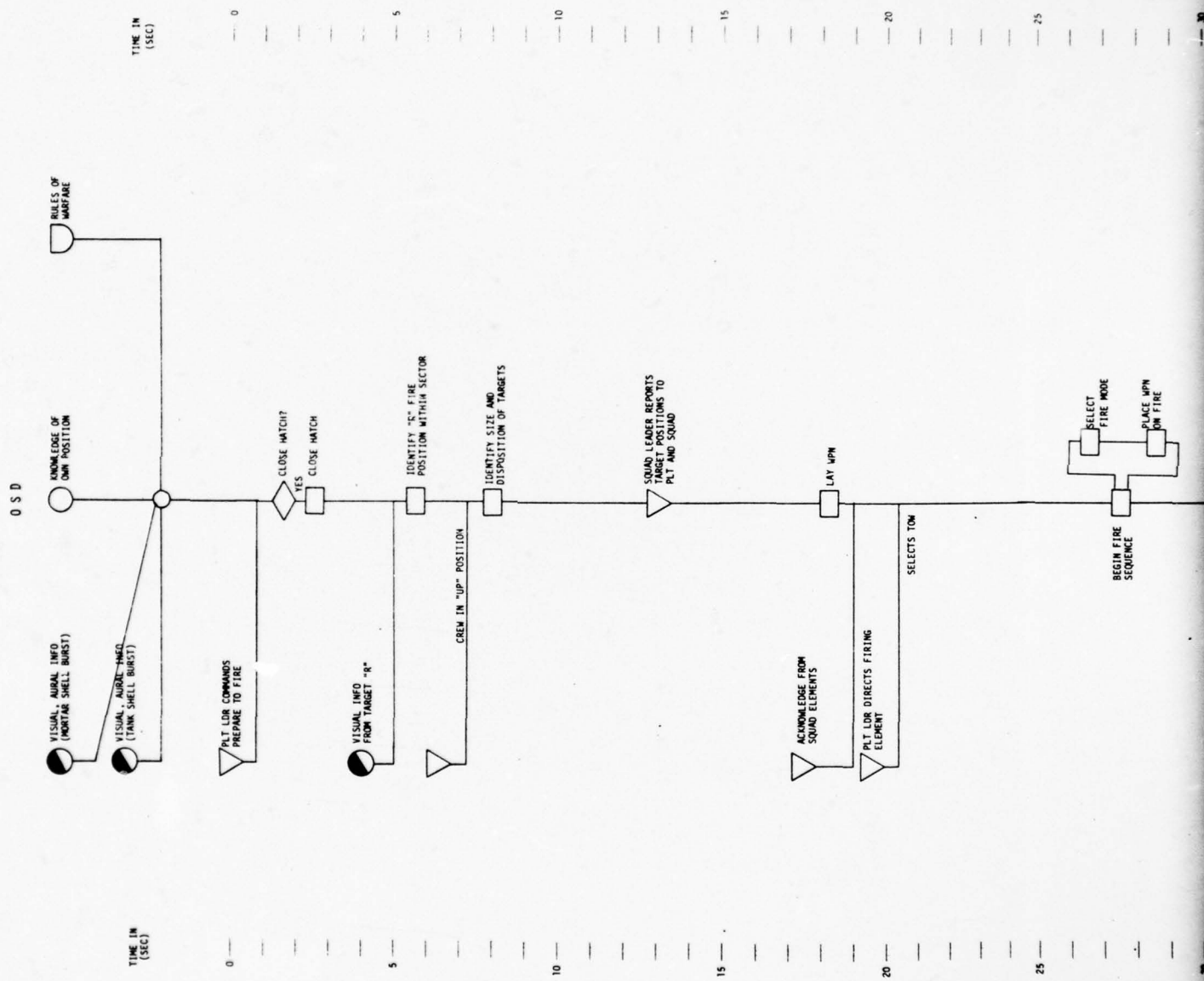


Figure 12. Mission segment one. 2-MAN turret, SOD LDR vehicle, reconnaissance mission, night.



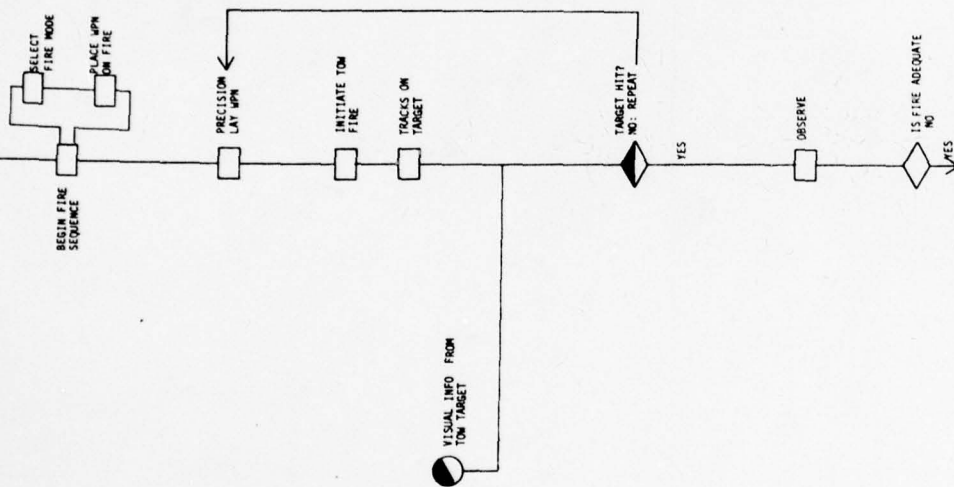
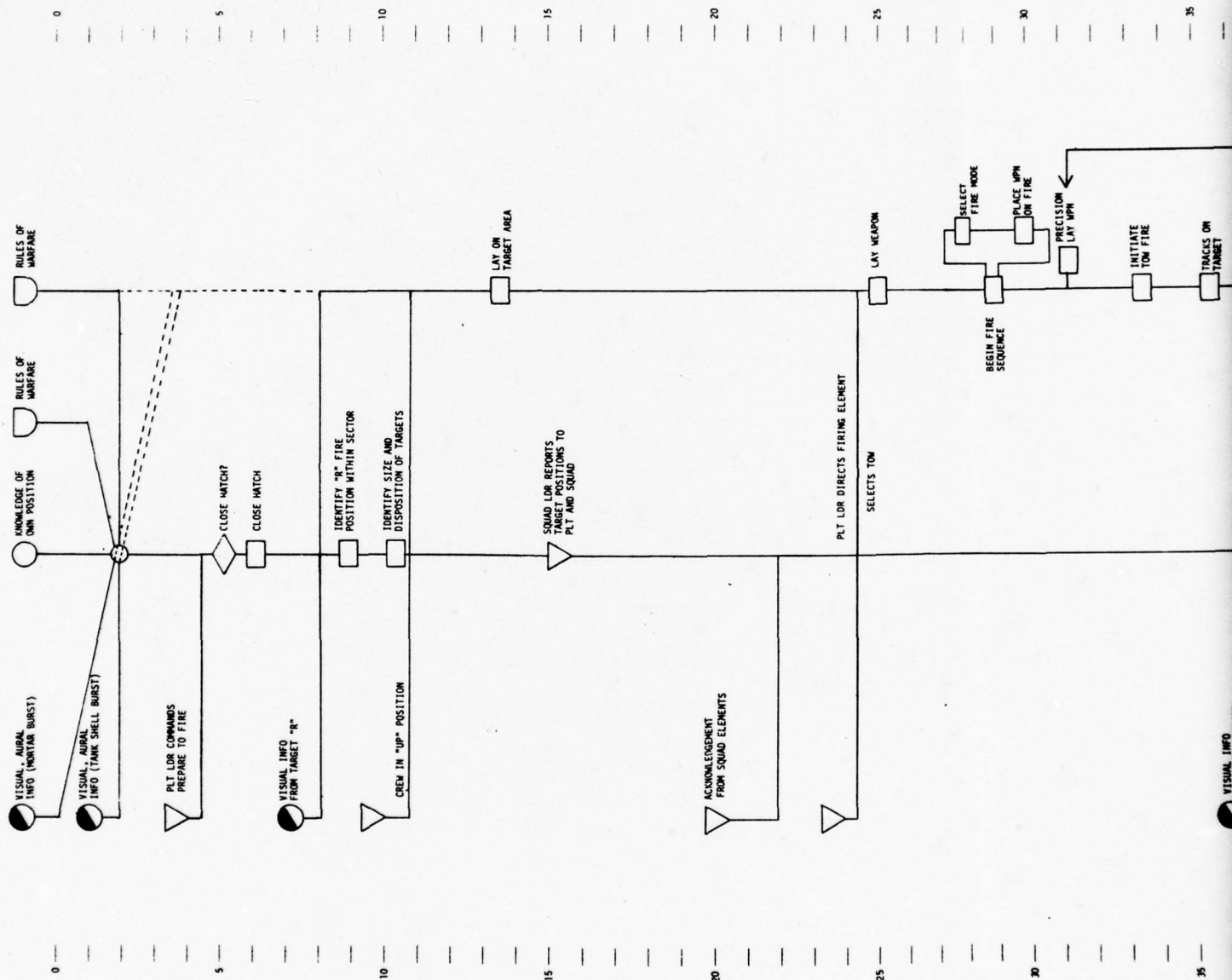


Figure 13. Mission segment two. 1-MAN turret, SQD LDR vehicle, defense, day.

2

TIME IN
(SEC)

OSD



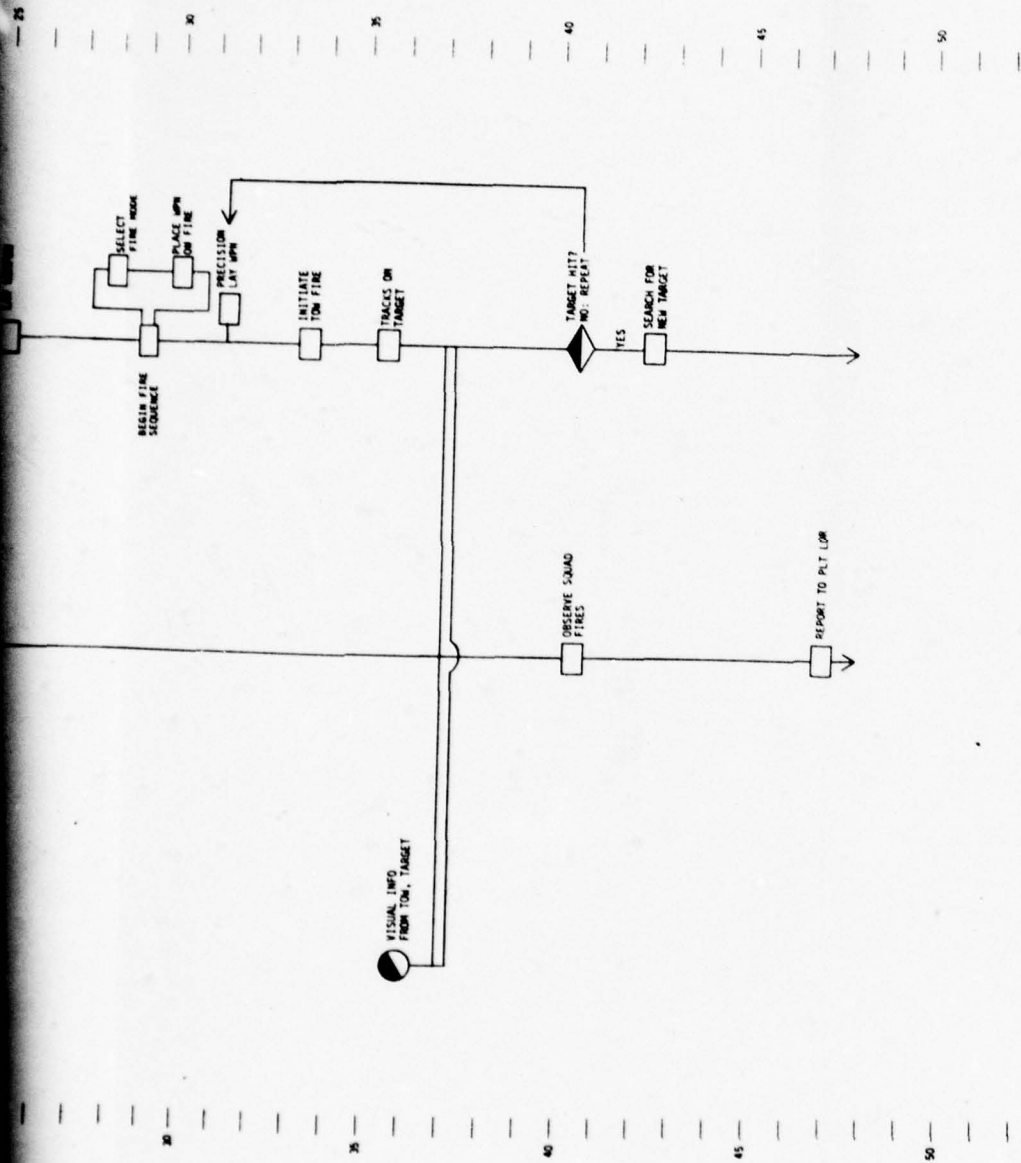
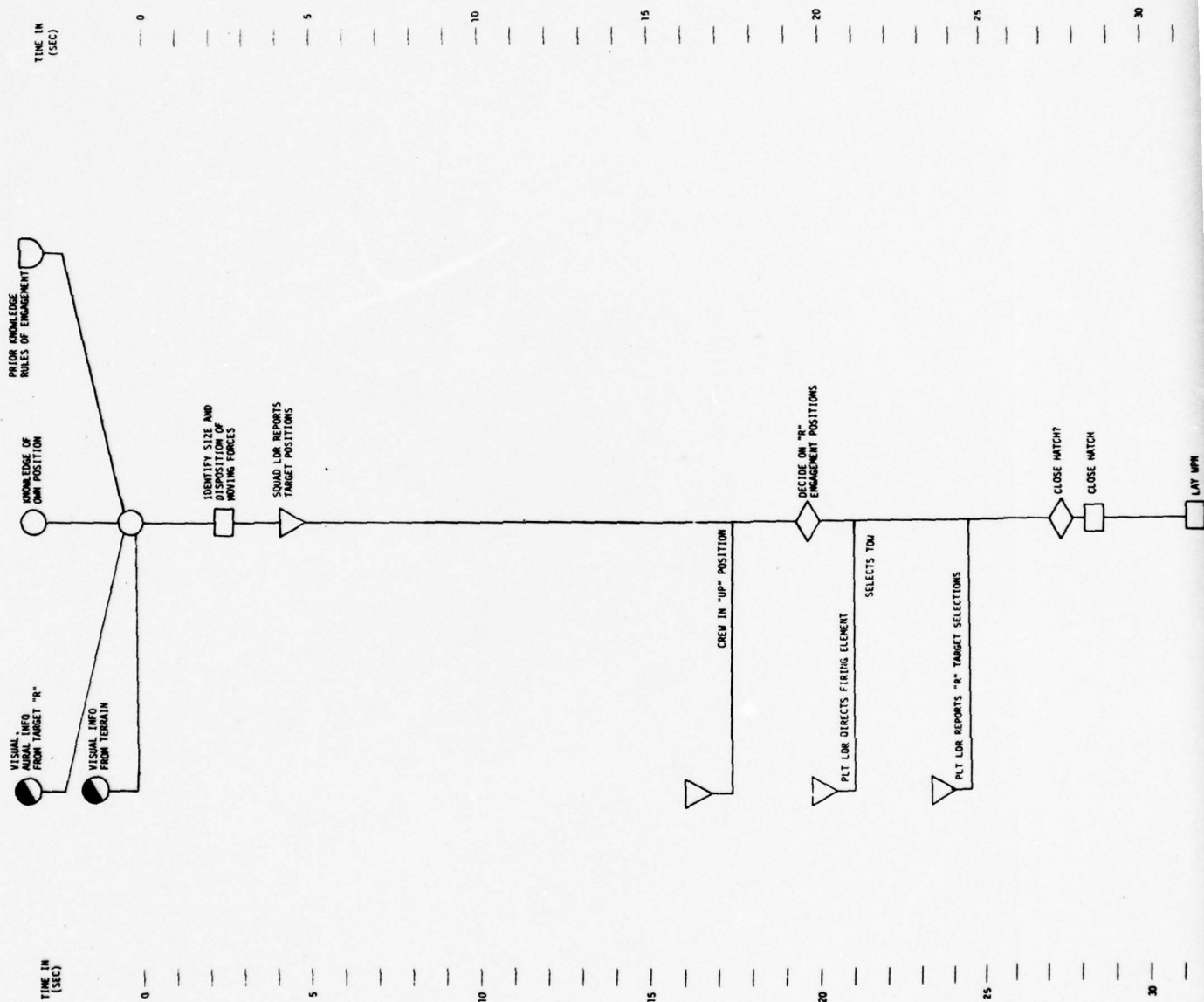


Figure 14. Mission segment two. 2-MAN turret, SQD LDR vehicle, defense, day.

2

0 S D



2

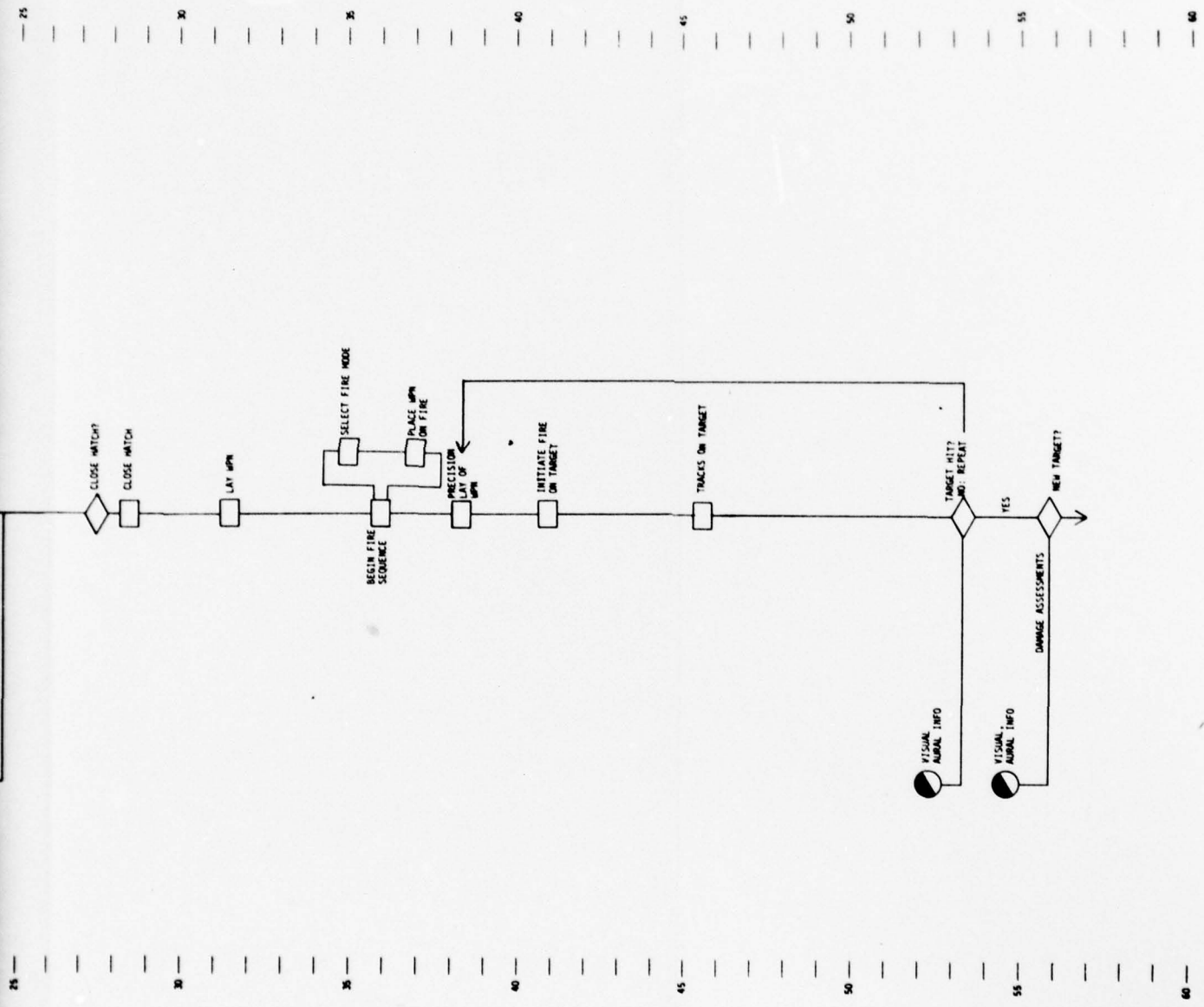
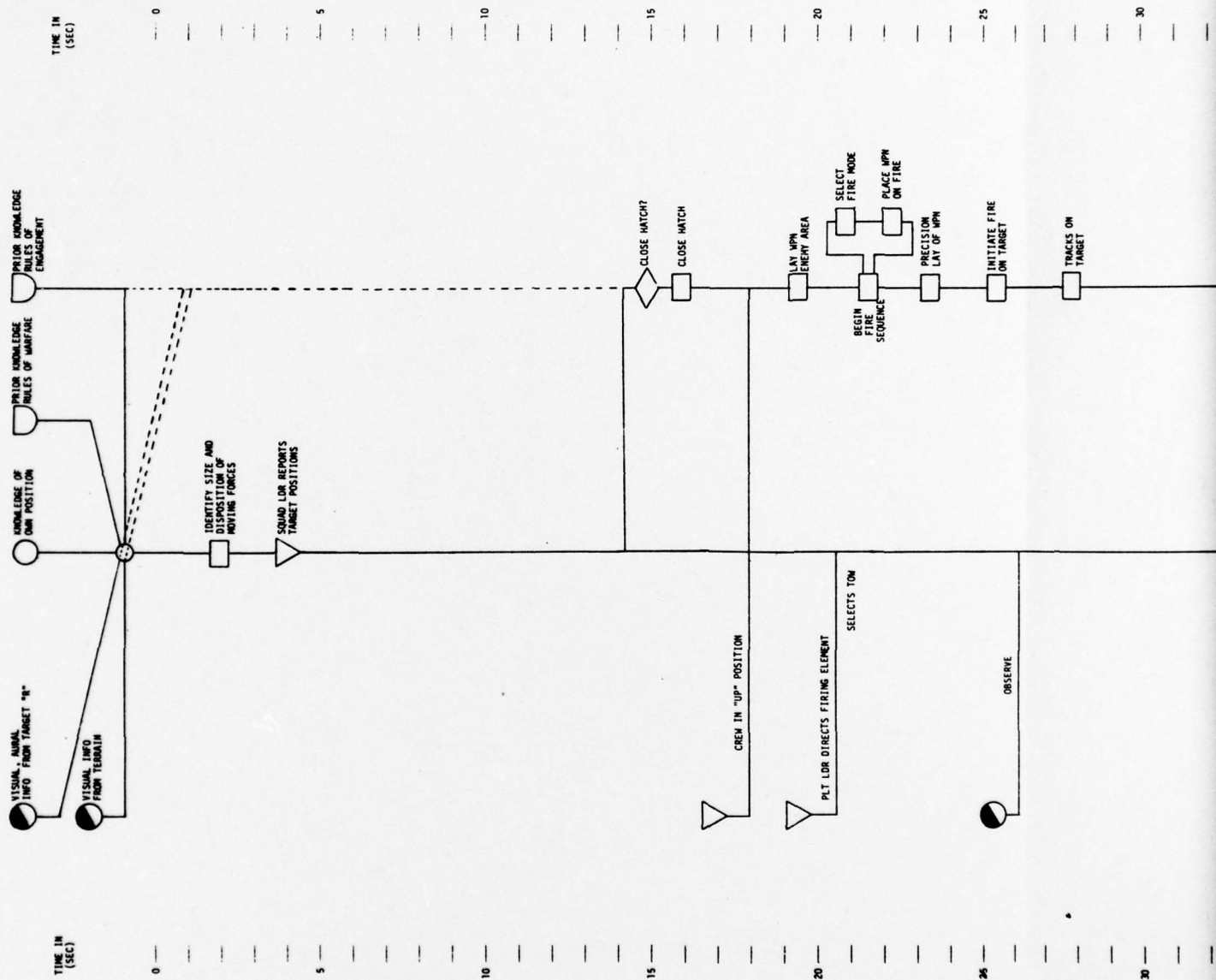


Figure 15. Mission segment three. 1-MAN turret, SQD LDR vehicle, withdrawal, day.

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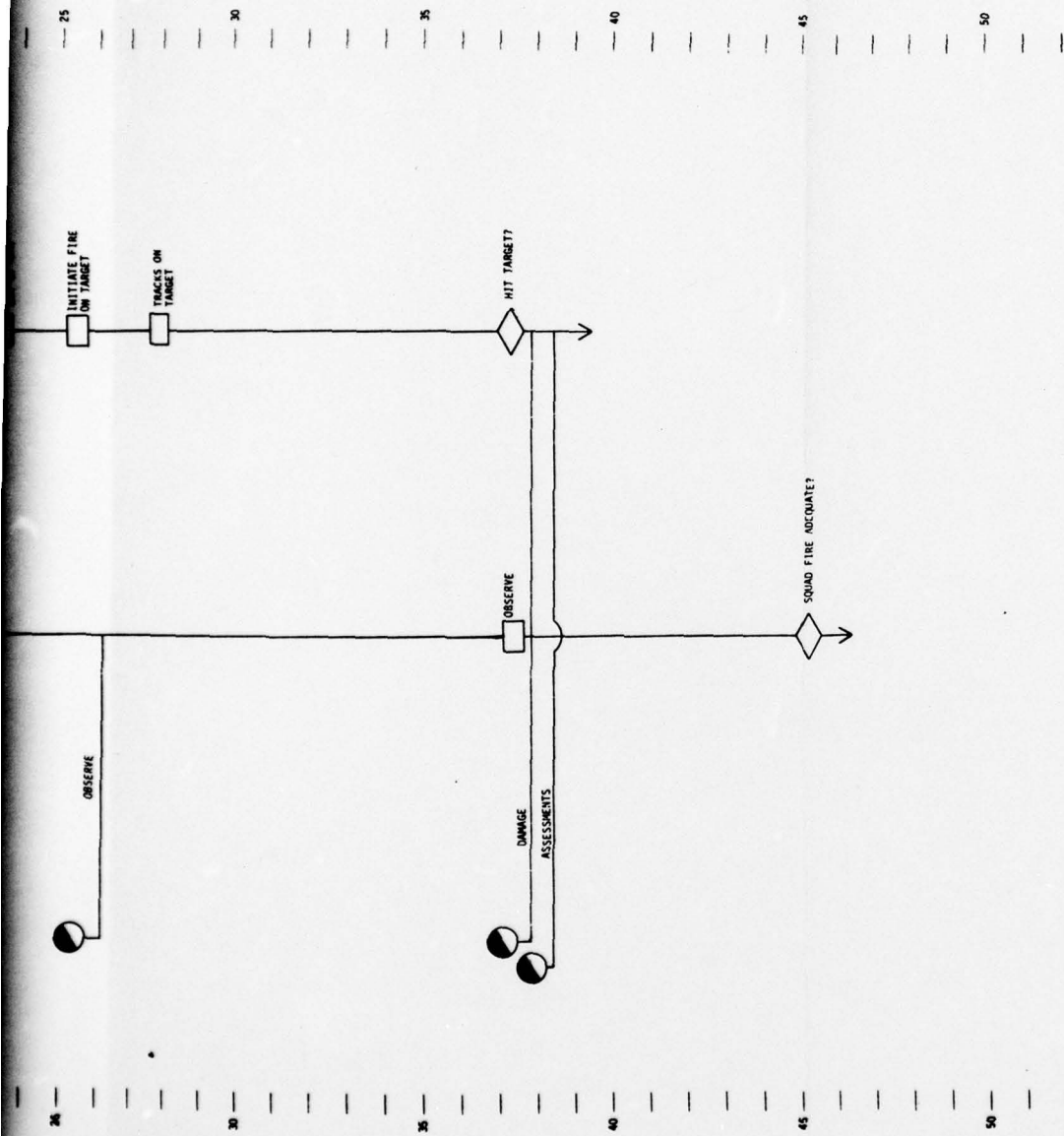


Figure 16. Mission segment three. 2-MAN turret, SQD LDR vehicle, withdrawal, day.

22

ARSV TURRET SKILL LEVEL ASSESSMENT

PROCEDURE

In order to respond to the question "What are the minimal skill levels required of operators within the turret?" analysis proceeded along the following sequence. FMC Corporation task lists prepared for a similar MICV/ARSV system were reviewed and updated to include tasks dictated by the addition of the multiple launch TOW and the Bushmaster to the system. These updated task lists were then reviewed and further edited by three NCOs experienced in armor and cavalry operations. The final task lists were then compared with the skill level task lists provided in the Draft Soldier's Manual, FM 17-11D, for matching with Skill Levels 2, 3 and/or 4.⁶

RESULTS

Following are task lists prepared for five turret operator positions to be occupied by enlisted men. The five MOS 11D positions to be assessed are:

- Squad leader/vehicle commander, 1-MAN turret
- Vehicle commander, 1-MAN turret
- Squad leader/vehicle commander, 2-MAN turret
- Vehicle commander, 2-MAN turret
- Gunner/observer, 2-MAN turret

Tables 5, 6, 7, 8 and 9 list the major tasks developed for each of the positions listed above. The first four vehicle commander positions are all similar in that they each include only five to eight tasks corresponding to tasks listed in FM 17-11D at the Skill Levels 2, 3, and/or 4. Additionally, seven to ten tasks in each list were considered sufficiently critical to require supplementary training upgrading MOS 11D training.

Table 9, listing the tasks developed for the gunner/observer occupying the second position in the 2-MAN turret, is different from the previous four jobs in that no tasks were found to correspond to tasks listed under Skill Levels 3 or 4 in FM 17-11D. Three tasks were found to correspond to Skill Level 2 tasks and nine tasks were considered sufficiently critical to require supplementary training upgrading MOS 11D training.

FMC Corporation had previously recommended upgrading of qualifications for crew members of the MICV/ARSV. Their recommendations did not

⁶ Field Manual 17-11D, Soldier's Manual (Draft). Department of the Army HQ, August 1975.

Table 5

ARSV CREWMAN--DUTIES, SQUAD LEADER/VEHICLE COMMANDER
(1-MAN TURRET)

Duties	FM 17-11D Skill Levels	Require Supple- mentary training
1. Directs vehicle and weapons operation and maintenance	2,3,4	
2. Operates laser rangefinder		x
3. Operates 25mm cannon system	2	
a. Needs assistance in loading		
b. Needs someone to observe operation and functioning of weapon		
c. Needs assistance in spotting rounds		
4. Communicates within and outside vehicle	2	
5. Operates turret		x
6. Performs pre- post-OP checks and assists in checks	1	
7. Spots rounds and assists in spotting	1	
8. Conducts dismounted reconnaissance	3	
9. Fires XM238 MG		
10. Installs and prepares 25mm cannon system		x
11. Boresights 25mm cannon and coax 7.62 MG		x
12. Installs and prepares TOW system and assists in preparation		x
13. Boresights TOW		x
14. Uses day/night sight for observation and primary weapon firing		x
15. Fires TOW on targets		x
16. Operates very short range ground surveillance radar		x
17. Performs vehicle navigation	1	
18. Locates and plots targets and terrain features on map	2	
19. Calls for fire	1	
20. Zeros day/night sight and secondary sight		x
21. Directs squad tactical operations and training	3,4	

Table 6

ARSV CREWMAN--DUTIES, VEHICLE COMMANDER
(1-MAN TURRET)

Duties	FM 17-11D Skill Levels	Require Supple- mentary training
1. Directs vehicle and weapons operations and maintenance	2,3,4	
2. Operates laser rangefinder		x
3. Operates 25mm cannon system	2	
a. Needs assistance in loading		
b. Needs someone to observe operation and functioning of weapon		
c. Needs assistance in spotting rounds		
4. Communicates within and outside vehicle	2	
5. Operates turret		x
6. Performs pre- post-OP checks and assists in checks	1	
7. Spots rounds and assists in spotting	1	
8. Conducts dismounted reconnaissance	3	
9. Fires XM238 MG		
10. Installs and prepares 25mm cannon system and assists in preparation		x
11. Boresights 25mm cannon and coax 7.62 MG		x
12. Installs and prepares TOW system and assists in preparation		x
13. Boresights TOW		x
14. Uses day/night sight for observation and primary weapon firing		x
15. Fires TOW on targets		x
16. Operates very short range ground surveillance radar		x
17. Performs vehicle navigation	1	
18. Locates and plots targets and terrain features on map	2	
19. Calls for fire	1	
20. Zeros day/night sight and secondary sight		x

Table 7

ARSV CREWMAN--DUTIES, SQUAD LEADER/VEHICLE COMMANDER (2-MAN TURRET)

Duties	FM 17-11D Skill Levels	Require Supple- mentary training
1. Directs vehicle and weapons operation and maintenance	2,3,4	
2. Operates laser rangefinder		x
3. Operates 25mm cannon system	2	
a. Needs assistance in loading		
b. Needs someone to observe operation and functioning of weapon		
c. Needs assistance in spotting rounds		
4. Communicates within and outside vehicle	2	
5. Operates turret		x
6. Performs pre- post-OP checks and assists in checks	1	
7. Spots rounds and assists in spotting rounds	1	
8. Conducts dismounted reconnaissance	3	
9. Directs fire of XM238 MG		
10. Assists in installing and preparing 25mm cannon system and 7.62 MG		x
11. Assists in boresighting 25mm cannon and coax 7.62 MG		
12. Must be trained to install and prepare TOW system for operation		x
13. Assists in boresighting TOW		
14. Uses day/night sight for observation and primary weapon firing		x
15. Fires TOW on targets		x
16. Operates very short range ground surveillance radar		x
17. Performs vehicle navigation	1	
18. Locates and plots targets and terrain features on map	2	
19. Calls for fire	1	
20. Directs squad tactical operations and training	3,4	

Table 8

ARSV CREWMAN--DUTIES, VEHICLE COMMANDER
(2-MAN TURRET)

Duties	FM 17-11D Skill Levels	Require supple- mentary training
1. Directs vehicle and weapons operations and maintenance	2,3,4	
2. Operates laser rangefinder		x
3. Operates 25mm cannon system	2	
a. Needs assistance in loading		
b. Needs someone to observe operation and functioning of weapon		
c. Needs assistance in spotting rounds		
4. Communicates within and outside vehicle	2	
5. Operates turret		x
6. Performs pre- post-OP checks and assists in checks	1	
7. Spots rounds and assists in spotting rounds		
8. Conducts dismounted reconnaissance	3	
9. Directs fire of XM238 MG		
10. Assists in installing and preparing 25mm cannon system and coax 7.62 MG		x
11. Assists in boresighting 25mm cannon and coax 7.62 MG		
12. Must be trained to install and prepare TOW system for operation		x
13. Assists in boresighting TOW		
14. Uses day/night sight and secondary sight for observation and primary weapon firing		x
15. Fires TOW on targets		x
16. Operates very short range ground surveillance radar		x
17. Performs vehicle navigation	1	
18. Locates and plots target and terrain features on map	2	
19. Calls for fire	1	

Table 9

ARSV CREWMAN--DUTIES, GUNNER/OBSERVER
(2-MAN TURRET)

Duties	FM 17-11D Skill Levels	Require supple- mentary training
1. Observes vehicle operations		
2. Operates laser rangefinder		x
3. Operates 25mm cannon system	2	
a. Needs assistance in loading		
b. Needs someone to observe operation and functioning of weapon		
c. Needs assistance in spotting rounds		
4. Communicates within and outside vehicle	2	
5. Operates turret		x
6. Assists in pre- post-OP checks	1	
7. Assists in spotting rounds	1	
8. Covers dismounted commander with weapons	2	
9. Operates XM238 MG and assists in operation		
10. Installs and prepares 25mm cannon system and coax 7.62 MG		x
11. Boresights 25mm cannon and coax 7.62 MG		x
12. Installs and prepares TOW system for operation and assists in preparation		x
13. Boresights TOW		x
14. Zeros day/night sight and secondary sight		x
15. Fires TOW on targets		x
16. Loads TOW and assists in loading		
17. Loads 25mm cannon and assists in loading		
18. Monitors and repairs malfunctions/operations in weapon feeding and firing mechanisms		x

contemplate the inclusion of the TOW or Bushmaster, but they did consider many subsystems and equipments anticipated for the new system. Their recommendations are reproduced in the Appendix.

CONCLUSIONS

With the addition of the supplementary training required for operation and maintenance of the new subsystems, weapons and special equipments, Skill Level 3 is appropriate and minimal for the four positions:

- Squad/leader vehicle commander, 1-MAN turret
- Vehicle commander, 1-MAN turret
- Squad leader/vehicle commander, 2-MAN turret
- Vehicle commander, 2-MAN turret

Certain tasks are so constraining and/or cumbersome as to require the assistance of one or more additional crewmen. Operation of the 25mm cannon system requires assistance in loading, in observation of functioning and in spotting rounds. Firing the TOW also requires the assistance of other personnel in spotting rounds and reloading. This assistance must be provided by the second man in the turret or by crewmen in the hull (in the 1-MAN configuration).

If these observation, loading, and communications functions are to be performed by crewman in hull stations, the design integration of the weapons into the turret must take into consideration the human performance requirements of crewmen in hull stations.

SUMMARY

Three missions segments were analyzed to determine the tasks and subtasks of the turret station operators in ARSVs in immediate contact with an enemy force. In each case the 1-MAN turret concept was compared with the 2-MAN turret concept by the development of operational sequence diagrams on the turret operations within the two turret concepts. In addition, the turret operator's duties were assessed as to their minimum skill level requirements.

Results of this analysis indicate that the combination of weapons systems tasks (TOW + Bushmaster + Coax 7.62 machine gun) along with the requirement for reconnaissance functions (observation and reporting) dictate the need for a 2-MAN turret. The necessity is determined by three factors:

- (1) The demands of operation of the weapons systems are such that reconnaissance functions are delayed and partially neglected during an engagement in the 1-MAN configuration. Initial contact with the enemy and engagement is precisely the time when reconnaissance functions including reporting are very important. The 2-MAN turret, on the other hand, provides great advantages in observation time and, generally,

quicker reporting, along with more time available to the vehicle commander for communications during an engagement. The 2-MAN turret concept permits firing TOW from the platoon leader or squad leader vehicle without sacrificing reconnaissance functions.

(2) The 2-MAN turret concept provides quicker contact-to-strike times and this advantage is especially significant in TOW engagements.

(3) The two-man turret concept provides one additional crewman needed to assist in observing weapons operation, spotting rounds, and loading.

The skill level assessment of turret operators' tasks resulted in skill levels comparable to those for tank crewman, Skill Level 3, for ground scout vehicle commanders and squad leaders and Skill Level 2 for the gunner/observer in the 2-MAN turret concept. These skill level training requirements must be supplemented to include training for the advanced subsystems and weapon systems contemplated for the MICV/ARSV.

APPENDIX

FMC Corporation Recommendations for Supplementary Training
of ARSV Crewmen

MOS 11D UPGRADING
REQUIRED FOR ARSV OPERATION

The ARSV will replace the M114 vehicle. The M114 has the following crew:

MOS 11D10 - Observer
MOS 11D20 - Driver
MOS 11D40 - Commander

The qualifications of MOS 11D (as defined in AR 611-201) will need to be upgraded as the ARSV enters the military system. This report identifies the areas of MOS 11D that will need upgrading.

1. All crewmen will need training on operation and crew maintenance of the following equipment items.
 - a. Primary weapon stabilization system (including both power and manual controls).
 - b. Safety precautions required in the use of the powered turret.
 - c. Primary weapon ammunition feed system (emphasis on loading procedures): booster, ammo boxes, auxiliary hand crank, oiler-link aligner.
 - d. Primary weapon fire controls - manual trigger, manual safety, fire control panel.
 - e. Primary weapon secondary sight.
 - f. Day/Night Sight - training on operation, crew maintenance and boresighting and zeroing procedures.
 - g. Reconnaissance devices
 - o Laser Rangefinder
 - o Very Short Range Ground Surveillance Radar
 - o AN/VDR-1 Vehicular Radiac Set
 - h. Winch - Use in self-recovery, use in encountering route hazards, operation and maintenance.
2. All crewmen will require training in the crew maintenance of the automotive systems which significantly differ from the M114.
 - a. ARSV fuel system is different (multifuel) and requires frequency straining and checking.

- b. ARSV has hydraulic brakes whereas the M114 had mechanical linkage.
 - c. Cooling system in the ARSV to be filled at the radiator and not the surge tank (M114).
 - d. Final drives have separate oil fill dipsticks on ARSV.
 - e. There are gauges on the ARSV fire extinguisher (not on M114).
 - f. ARSV has a different type of air filter.
 - g. No ignition system in ARSV.
 - h. ARSV has tow-to-start controls not found in the M114.
 - i. Use of a belt tensonometer.
3. Training to all crewmen will be required in driving the ARSV. Areas of particular emphasis are listed below.
- a. ARSV has neutral steer. M114 does not.
 - b. M114 has a separate gear selector for land/water operation. ARSV does not have this.
 - c. The ARSV performance capabilities are higher than the M114.
 - d. The ARSV has a steering wheel; the M114 has a steering bar.
 - e. The reverse shift position is in the opposite direction on the ARSV.
 - f. Starting and stopping of the ARSV multifuel engine requires different procedures.
 - g. Water operation of the ARSV varies from the M114 in both procedures and vehicle speed.
 - h. ARSV has stabilized primary weapon. M114 does not; driver must be conscious of orientation of weapon barrel.

4. Assuming the Observer will not sit in the gunner's station, the qualifications of the Observer (MOS 11D10) should be upgraded to improve the efficiency of the ARSV system. The Observer should have the ability to:

- a. Use the M60D machine gun to conduct reconnaissance by fire.
- b. Recognize and identify targets using the Very Short Range Ground Surveillance Radar.
- c. Use the M8 Portable Automatic Chemical Detector and the AN/VDR-1 Vehicular Radiac Set (MOS 11D10 is presently not qualified for this - according to implications of AR 611-201).